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(54) **METHODS PROVIDING SIGNAL SYNCHRONIZATION AND RELATED NETWORKS AND DEVICES**

METHODEN ZUR SIGNAL-SYNCHRONISATION VON NETZWERKEN UND  
NETZWERKELEMENTEN

MÉTHODES POUR LA SYNCHRONISATION DE SIGNAL DES RESEAUX ET ELEMENTS DE  
RESEAU

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## Description

### BACKGROUND

**[0001]** In a typical cellular radio system, wireless terminals (also known as mobile stations and/or user equipment units (UEs)) communicate via a radio access network (RAN) to one or more core networks. User equipment units may include mobile telephones ("cellular" telephones) and/or other processing devices with wireless communication capability, such as, for example, portable, pocket, hand-held, laptop computers, which communicate voice and/or data with the RAN.

**[0002]** The RAN covers a geographical area which is divided into cell areas, with each cell area being served by a base station, e.g., a radio base station (RBS), which in some networks is also called a "NodeB" or enhanced NodeB "eNodeB", which can be abbreviated "eNB." A cell area is a geographical area where radio coverage is provided by the radio base station equipment at a base station site. The base stations communicate over the air interface operating on radio frequencies with UEs within range of the base stations.

**[0003]** In some versions of the radio access network, several base stations are typically connected (e.g., by landlines or microwave) to a radio network controller (RNC). The radio network controller, also sometimes termed a base station controller (BSC), supervises and coordinates various activities of the plural base stations connected thereto. The radio network controllers are typically connected to one or more core networks.

**[0004]** The Universal Mobile Telecommunications System (UMTS) is a third generation mobile communication system, which evolved from the Global System for Mobile Communications (GSM), and is intended to provide improved mobile communication services based on Wideband Code Division Multiple Access (WCDMA) access technology. UTRAN, short for UMTS Terrestrial Radio Access Network, is a collective term for the Node B's and Radio Network Controllers which make up the UMTS radio access network. Thus, UTRAN is essentially a radio access network using wideband code division multiple access for user equipment units.

**[0005]** The Third Generation Partnership Project (3GPP) has undertaken to evolve further the UTRAN and GSM based radio access network technologies. In this regard, specifications for the Evolved Universal Terrestrial Radio Access Network (E-UTRAN) are ongoing within 3GPP. The Evolved Universal Terrestrial Radio Access Network (E-UTRAN) comprises the Long Term Evolution (LTE) and System Architecture Evolution (SAE).

**[0006]** Figure 1 is a simplified block diagram of a Long Term Evolution (LTE) RAN 100. The LTE RAN 100 is a variant of a 3GPP RAN where radio base station nodes (eNodeBs) are connected directly to a core network 130 rather than to radio network controller (RNC) nodes. In general, in LTE the functions of a radio network controller (RNC) node are performed by the radio base stations

nodes. Each of the radio base station nodes (eNodeBs) 122-1, 122-2, ... 122-M communicate with UEs (e.g., UE 110-1, 110-2, 110-3, ... 110-L) that are within their respective communication service cells. The radio base station nodes (eNodeBs) can communicate with one another through an X2 interface and with the core network 130 through S1 interfaces, as is well known to one who is skilled in the art.

**[0007]** The LTE standard is based on multi-carrier based radio access schemes such as Orthogonal Frequency-Division Multiplexing (OFDM) in the downlink and Discrete Fourier Transform (DFT)-spread OFDM in the uplink. The OFDM technique distributes the data over a large number of carriers that are spaced apart at precise frequencies. This spacing provides the "orthogonality" in this technique which avoids having demodulators see frequencies other than their own. The benefits of OFDM are high spectral efficiency, resiliency to RF interference, and lower multi-path distortion.

**[0008]** Figure 2 illustrates a resource grid for frequency and time resource elements (REs), where each resource element corresponds to one OFDM subcarrier during one OFDM symbol interval. In the time domain, LTE downlink transmissions may be organized into radio frames of 10 ms, and each radio frame may consist of ten equally-sized subframes of length  $T_{\text{subframe}} = 1$  ms, as illustrated in Figure 3.

**[0009]** One or more resource schedulers in the LTE RAN 100 allocate resources for uplink and downlink in terms of resource blocks, where a resource block corresponds to one slot (0.5 ms) in the time domain and 12 subcarriers in the frequency domain. Resource blocks are numbered in the frequency domain, starting with 0 from one end of the system bandwidth.

**[0010]** The LTE Rel-8 standard has recently been standardized, supporting bandwidths up to 20 MHz. 3GPP has initiated work on LTE Rel-10 in order to support bandwidths larger than 20 MHz and support other requirements defined by IMT-Advanced Requirements. Another requirement for LTE Rel-10 is to provide backward compatibility with LTE Rel-8, including spectrum compatibility. This requirement may cause an LTE Rel-10 carrier to appear as a number of LTE carriers to an LTE Rel-8 terminal. Each such carrier can be referred to as a *Component Carrier* (CC). In particular for early LTE Rel-10 deployments it can be expected that there will be a smaller number of LTE Rel-10-capable terminals compared to many LTE legacy terminals. Therefore, it can be particularly important to ensure efficient use of the wide carrier by legacy terminals, such as by enabling legacy terminals to be scheduled in all parts of the wideband LTE Rel-10 carrier. One way to obtain this may be by means of Carrier Aggregation. Carrier Aggregation refers to an LTE Rel-10 terminal being configured to receive multiple CC, where the CC have, or at least the possibility to have, the same structure as a Rel-8 carrier. The same structure as Rel-8 implies that all Rel-8 signals, e.g. (primary and secondary) synchronization signals,

reference signals, system information are transmitted on each carrier. Figure 4 graphically illustrates an exemplary 100 MHz Carrier Aggregation of five 20MHz CCs.

**[0011]** Referring to Figure 4, the number of aggregated CC as well as the bandwidth of the individual CC may be different for uplink and downlink. A symmetric configuration refers to the case where the number of CCs in downlink and uplink is the same whereas an asymmetric configuration refers to the case that the numbers of CCs in downlink and uplink are different. It is important to note that the number of CCs offered by the network may be different from the number of CCs seen by a terminal. For example, a terminal may support more downlink CCs than uplink CCs, even though the network offers the same number of uplink and downlink CCs.

**[0012]** During initial access a LTE Rel-10 terminal may operate similarly to a LTE Rel-8 terminal. Upon successful connection to the network, a terminal may - depending on its own capabilities and the network - be configured with additional CCs in the UL and DL. Configuration is based on Radio Resource Control (RRC). Due to the heavy signaling and rather slow speed of RRC signaling, a terminal may be configured with multiple CCs even though not all of them are currently used. If a terminal is configured for multiple CCs it may have to monitor Physical Downlink Control Channel (PDCCH) and Physical Downlink Shared Channel (PDSCH) for all DL CCs. However, such terminal configuration may necessitate use of a wider receiver bandwidth, higher sampling rates, etc. resulting in high power consumption.

Configuration of additional component carriers is discussed for example in R2-104195, "Corrections and new Agreements on Carrier Aggregation", Nokia Siemens Networks.

## SUMMARY

**[0013]** The invention is defined in the independent claims. Advantageous embodiments are set out in the dependent claims. According to some examples, a method of providing signal synchronization for a radio access network may include transmitting a first carrier including synchronization signals on a first frequency from the radio access network. Information relating the first carrier on the first frequency with a second carrier on a second frequency may be transmitted from the radio access network, with the information being intended to be used in synchronization by the wireless terminal upon addition of the second carrier. Moreover, the first and second frequencies may be different. In addition, a command to add the second carrier as a downlink for transmissions may be transmitted to the wireless terminal.

**[0014]** The first and second carriers may be time aligned at the user equipment, and the synchronization signals may be transmitted in periodic resource elements of the first carrier. The information relating the second carrier with the first carrier may include a list of a plurality of second carriers on a respective plurality of second

frequencies that are related with the first carrier, and/or the information relating the second carrier with the first carrier may include a list identifying a plurality of first carriers on a respective plurality of first frequencies that are related with the second carrier.

**[0015]** The first carrier may be configured as a downlink to the wireless terminal, and transmitting the information relating the second carrier with the first carrier may include transmitting the information over the first carrier to the wireless terminal. Transmitting the information relating the second carrier with the first carrier may include transmitting the information to the wireless terminal with the command to add the second carrier. Transmitting the information relating the second carrier with the first carrier may include transmitting the information over a third frequency different than the first frequency and different than the second frequency.

**[0016]** After transmitting the information and the command to add the second carrier, acknowledgment may be received from the wireless terminal indicating synchronization and/or configuration of the second carrier at the wireless terminal. Responsive to receiving the acknowledgment, downlink data may be transmitted over the second carrier to the wireless terminal.

**[0017]** Transmitting the command to add the second carrier may include transmitting a flag having one of a first value and a second value. The first value may instruct the wireless terminal to synchronize and/or configure the second carrier using the synchronization signals of the first carrier, and the second value may instruct the wireless terminal to synchronize and/or configure the second carrier without using the synchronization signals of the first carrier.

**[0018]** According to some other examples, signal synchronization may be provided for a wireless terminal communicating with a radio access network that transmits a first carrier including synchronization signals on a first frequency. More particularly, information relating a second carrier on a second frequency with the first carrier on the first frequency may be received from the radio access network, and a command to add the second carrier as a downlink for transmissions may be received from the radio access network. Responsive to receiving the command to add the second carrier, the second carrier on the second frequency may be synchronized and/or configured by the wireless terminal using the synchronization signals of the first carrier on the first frequency.

**[0019]** The first and second carriers may be time aligned, and the synchronization signals may be transmitted by the radio access network in periodic resource elements of the first carrier. The information relating the second carrier with the first carrier may include a list of a plurality of second carriers on a respective plurality of second frequencies that are related with the first carrier, and/or the information relating the second carrier with the first carrier may include a list identifying a plurality of first carriers on a respective plurality of first frequencies that are related with the second carrier.

**[0020]** The first carrier may be configured as a downlink from the radio access network to the wireless terminal, and receiving the information relating the second carrier with the first carrier may include receiving the information over the first carrier at the wireless terminal. Receiving the information relating the second carrier with the first carrier may include receiving the information at the wireless terminal with the command to add the second carrier. Receiving the information relating the second carrier with the first carrier may include receiving the information over a third frequency different than the first frequency and different than the second frequency.

**[0021]** Receiving the command to add the second carrier may include receiving a flag having one of a first value and a second value. Synchronizing and/or configuring the second carrier may include synchronizing and/or configuring the second carrier using the synchronization signals of the first carrier responsive to receiving the flag having the first value, and synchronizing and/or configuring the second carrier without using the synchronization signals of the first carrier responsive to receiving the flag having the second value.

**[0022]** Before receiving the command, a third carrier may be configured on a third frequency as a downlink carrier for transmissions from the radio access network to the wireless terminal. Responsive to receiving the flag having the first value, the wireless terminal may synchronize and/or configure the second carrier on the second frequency using the synchronization signals of the first carrier on the first frequency. Responsive to receiving the flag having the second value, the wireless terminal may synchronize and/or configure the second carrier on the second frequency using synchronization signals of the third carrier on the third frequency.

**[0023]** According to still other examples, a radio access network node may include radio frequency circuitry configured to transmit a first carrier including synchronization signals on a first frequency. In addition, a resource scheduler may be coupled to the radio frequency circuitry, with the resource scheduler being configured to transmit information relating the first carrier on the first frequency with a second carrier on the second frequency through the radio frequency circuitry to a wireless terminal. The resource scheduler may also be configured to transmit a command to add the second carrier on the second frequency as a downlink for transmissions to the wireless terminal, and the command to add the second carrier may be transmitted through the radio frequency circuitry to the wireless terminal. The first and second frequencies are different, and the information is intended to be used in synchronization by the wireless terminal upon addition of the second carrier.

**[0024]** According to yet other examples, a wireless terminal may be configured for communication with a radio access network that transmits a first carrier including synchronization signals on a first frequency. The wireless terminal may include a processor configured to receive information relating a second carrier on a second frequency

with the first carrier on the first frequency with the information being received from the radio access network. The processor may be further configured to receive a command to add the second carrier as a downlink for transmissions from the radio access network to the wireless terminal, and to synchronize and/or configure the second carrier on the second frequency using the synchronization signals of the first carrier on the first frequency responsive to receiving the command to add the second carrier.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0025]** The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate certain embodiment(s) of the invention. In the drawings:

Figure 1 is a block diagram of a LTE RAN;

Figure 2 illustrates a conventional resource grid of frequency and time resource elements that can be scheduled for communication use between a network node and UEs;

Figure 3 illustrates an exemplary LTE downlink radio frame that is divided into subframes;

Figure 4 illustrates an exemplary Carrier Aggregation of Component Carriers;

Figures 5A and 5B illustrate an exemplary heterogeneous network having three cells that can cause severe inter-cell interference;

Figure 6 illustrates one frequency reuse pattern that may be employed in the exemplary heterogeneous network of Figure 5;

Figures 7A and 7B illustrate some other frequency reuse patterns that may be employed in the exemplary heterogeneous network of Figure 5;

Figure 8 illustrates a network that includes a macro antenna and a Remote Radio Head (RRH) where two component carriers are time-aligned at transmission (time 0) but are no longer time-aligned at reception;

Figure 9 illustrates a flowchart of exemplary operations and methods that may be carried out by a RAN to notify one or more terminals (UEs) of a SMCC that should be used for synchronization of a SSCC;

Figure 10 illustrates a flowchart of exemplary operations and methods that may be carried out by a terminal (UE) to perform aided synchronization or individual synchronization;

Figure 11 illustrates a flowchart of exemplary operations and methods that may be carried out by a RAN to notify one or more terminals (UEs) of a SS-CCL;

Figure 12 illustrates a flowchart of exemplary operations and methods that may be carried out by a terminal (UE) to perform aided synchronization or individual synchronization; and

Figure 13 is a block diagram of a portion of a RAN and a plurality of UEs that are configured according to some embodiments of the present invention.

Figure 14 illustrates a flow chart of exemplary operations and methods that may be carried out by a RAN to provide synchronization information.

Figure 15 illustrates a flow chart of exemplary operations and methods that may be carried out by a terminal (UE) to provide synchronization.

## DETAILED DESCRIPTION

**[0026]** The invention will now be described more fully hereinafter with reference to the accompanying drawings, in which embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art.

**[0027]** For purposes of illustration and explanation only, various embodiments of the present invention are described herein in the context of operating in a LTE RAN, such as the RAN 100 of Figure 1. It will be understood, however, that the present invention is not limited to such embodiments and may be embodied generally in any type of RAN that is configured to transmit and/or receive according to one or more RATs.

**[0028]** To mitigate one or more of the above-described problems, LTE Rel-10 supports activation of CCs in addition to configuration of CCs. The terminal monitors only PDCCH and PDSCH for configured and activated CCs. Since activation is based on Medium Access Control (MAC) control elements - which are faster than RRC signaling - activation/de-activation can follow the number of CCs that is required to fulfill the current data rate needs. Upon arrival of large data amounts multiple CCs are activated, used for data transmission, and de-activated if not needed anymore. All but one CC - the DL Primary CC (DL PCC) - can be de-activated. Activation provides therefore the possibility to configure multiple CC but only activate them on an as-needed basis. Most of the time a terminal would have one or very few CCs activated resulting in a lower reception bandwidth and thus lower battery consumption.

**[0029]** It is to be understood that the present invention is not limited to the particular terminology used herein. For example, the present invention is not limited to the various terms that have been used to describe LTE carrier aggregation, such as, Component Carriers (abbreviated CCs) and other terminology that is used in the above-description and by 3GPP for definition of the LTE standard. The present invention is further applicable to, for example, RANs that are defined/described using terms like multi-cell or dual-cell operation, such as with a Primary Serving Cell and potentially multiple Secondary Serving Cells, or the like.

**[0030]** A resource scheduler carries out scheduling of a CC on the PDCCH via downlink assignments. Control information on the PDCCH is formatted as a Downlink Control Information (DCI) message. In Rel-8, a terminal only operates with one DL and one UL CC, the association between DL assignment, UL grants and the corresponding DL and UL CCs is therefore clear. In Rel-10, two modes of Carrier Aggregation need to be distinguished. The first mode of operation is very similar to the operation of multiple Rel-8 terminals in that a DL assignment or UL grant contained in a DCI message transmitted on a CC is either valid for the DL CC itself or for associated (either via cell-specific or UE specific linking) UL CC. The second mode of operation augments a DCI message with the Carrier Indicator Field (CIF). A DCI containing a DL assignment with CIF is valid for that DL CC indicated with CIF and a DCI containing a UL grant with CIF is valid for the indicated UL CC.

## Carrier Aggregation in Heterogeneous Network Deployments:

**[0031]** Some embodiments of the present invention are directed to carrier synchronization for networks that provide carrier aggregation. These embodiments are described in the context of a heterogeneous network having two cell layers, here referred to as "macro layer" and "pico layer", respectively, although the invention is not limited to that exemplary heterogeneous network, and other embodiments of the invention may be implemented in other networks (such as homogeneous networks). No specific assumptions are made regarding the characteristics of the different cell layers. In some embodiments, the different cell layers may correspond to cells having substantially different coverage area sizes (fundamentally defined by the coverage area of the basic control signals/channels, such as Primary Synchronization Channel, (PSS), Secondary Synchronization Channel (SSS), Physical Broadcast Channel (PBCH), Cell Specific Reference Signals (CRS), PDCCH, etc). In the exemplary heterogeneous network, a referenced "pico layer" can be a micro layer, a conventional outdoor or indoor pico layer, a layer consisting of relays, or a Home eNB (HeNB) layer.

**[0032]** Various inter-cell interference scenarios may occur for co-channel heterogeneous network deployments. Figures 5A and 5B illustrate an exemplary heterogeneous network having three cells that can cause severe inter-cell interference. Figure 5A illustrates how a HeNB may cause interference towards a macro cell user that has no access to the femto cell (case (a)), and how a macro cell edge user may cause interference towards the HeNB due to no femto cell access (case (b)). Figure 5B illustrates how interference from a macro eNB towards a pico cell (or a femto cell) edge user may increase (up to  $\Delta$ ) if path loss based serving cell selection is used instead of strongest received downlink signal.

**[0033]** The major inter-cell interference issues and

concerns of co-channel heterogeneous network deployments in LTE refer to interference towards resources that cannot rely on inter-cell interference coordination. For schedulable data transmissions such as PDSCH and Physical Uplink Shared Channel (PUSCH), inter-cell interference can be coordinated via soft or hard physical resource partitioning, e.g. by exchanging coordination information across layers/cells via the X2 interfaces.

**[0034]** It is desirable for legacy UEs to be able to operate and benefit from heterogeneous network deployments, for example by accessing pico layers to improve uplink performance even if the received signal power from the macro layer is significantly higher. Such cell selection can be achieved, for example, by use of offset in Reference Signal Received Power (RSRP) measurements carried out by the UE (corresponding to  $\Delta$  in Figure 5B). The current specification allows for an offset up to 24 dB, which should be sufficient for most heterogeneous network scenarios.

**[0035]** To mitigate severe downlink inter-cell interference from macro eNBs towards control regions of pico subframes, operating layers on different carriers may be necessary to ensure robust communications for legacy UEs in heterogeneous network deployments. However, such configuration implies that the whole system bandwidth will not always be available for legacy UEs and may result in reduced user throughputs. One example of reduced throughput would be a split of a contiguous system bandwidth of 20 MHz into two carriers, e.g. 10 MHz bandwidth on each carrier.

**[0036]** As explained above, operating different layers on different non-overlapping carrier frequencies may lead to resource-utilization inefficiency. With the heterogeneous network illustration depicted in Figure 6, this would imply that the overall available spectrum consists of two carriers f1 and f2, with f1 and f2 being exclusively used in the macro and pico layer, respectively. In the further explanation below, it is assumed that the layers are synchronized with time aligned eNB transmissions and that f1 and f2 have non-overlapping frequency bands.

**[0037]** In many cases it can be assumed that the pico layer is deployed to carry the main part of the traffic, and especially, provide the highest data rates, while the macro layer provides full-area coverage to fill any coverage holes within the pico layer. In such a case it is desirable that the full bandwidth, corresponding to carrier f1 and f2, is available for data transmission within the pico layer. It may also be desirable for the full bandwidth (f1 and f2) to also be available for data transmission within the macro layer, although the importance of this may be less than ensuring full-bandwidth availability in the pico layer.

**[0038]** As explained above, sharing of the resources (operation on the same set of carriers) between the cell layers for data transmission can be accomplished by means of Inter-Cell Interference Coordination (ICIC) methods and operations that can be more or less dynamic depending on the coordination capabilities between

the layers and radio base stations. A potentially key issue is to enable transmission of signals/channels that cannot rely on traditional ICIC methods but need to be transmitted on specific, well-defined, resources, including:

- 1) The synchronization signals (Primary Synchronization Channel (PSS)/Secondary Synchronization Channel (SSS));
- 2) The Physical Broadcast Channel (PBCH); and
- 3) L1/L2 control channels (Physical Downlink Control Channel (PDCCH), Physical Control Format Indicator Channel (PCFICH) and Physical Hybrid-ARQ Indicator Channel (PHICH)).

**[0039]** All these signals must be transmitted on at least one downlink carrier within each cell layer. It is assumed that this primary carrier corresponds to carrier f1 in the macro layer and carrier f2 in the pico layer.

**[0040]** For the downlink, three cases are shown in Figures 7A and 7B. Case 1 differs from Case 2 (both shown in Figure 7A) with respect to Open Subscriber Group (OSG). In Case 3 (shown in Figure 7C), both carriers, f1 and f2, are available also at the macro layer. The three cases and exemplary operations and methods carried out by the associated RAN (e.g., by a resource scheduler therein, etc.) and UEs are further explained below.

#### Case 1 Of Carrier Aggregation In Heterogeneous Network Deployments:

**[0041]** Carrier f1 (the macro PCC) should be available for PDSCH transmission also within the pico layer. A UE is controlled to access the macro layer when the path loss to the macro layer is of the same order or smaller compared to the path loss to the pico layer.

**[0042]** In this case, the basic downlink control signals/channels above can be transmitted on f1 also in the pico layer with no severe interference to UEs accessing the macro layer. Thus both f1 and f2 can be deployed as "normal" (release 8 compatible) carriers in the pico layer. However, a legacy UE can access f1 only close to the pico cell site where the path loss to the pico cell is much smaller than the path-loss to the macro cell, in order to avoid strong control-channel interference from the macro cell. Closer to the pico-cell border of the pico cell, Rel-10 UEs access on f2, to avoid strong interference to PSS/SSS and PBCH from the macro cell, but could be scheduled using PDSCH transmission on f1, using cross-carrier scheduling with PDCCH on f2. Note that, to avoid interference from macro Cell Specific Reference Signals (CRS), pico-cell Physical Downlink Shared Channel (PDSCH) transmission on f1 must rely on UE-specific reference signals (RS) for channel estimation, at least when the UE is close to the pico-cell border. One might consider using frequency shifts of CRS across layers but macro CRS would then cause interference towards the data resource elements of the pico.

### Case 2 Of Carrier Aggregation In Heterogeneous Network Deployments:

[0043] Similar to case 1, carrier f1 should be available for PDSCH transmission also within the pico layer. However, a UE should be configured to access the macro cell even when close to the pico cell.

[0044] This scenario may occur when the pico layer consists of HeNBs belonging to Closed Subscriber Groups (CSGs) and where a UE not belonging to the CSG approaches HeNB. In this case, the pico layer must not transmit the channels above (PSS/SSS, Physical Broadcast CHannel (PBCH), CRS, PDCCH, etc.) on f1 in order to avoid interference to the UEs that are accessing the macro layer in the vicinity of a pico site. Rather, the corresponding resource elements should be empty. Thus, legacy UEs can only access the pico layer on f2 while release 10 UEs can be scheduled on both f1 and f2 in the same way as for case 1.

### Case 3 Of Carrier Aggregation In Heterogeneous Network Deployments:

[0045] In addition to carrier f1 being available for PDSCH transmission within the pico layer, carrier f2 should be available for PDSCH transmission within the macro layer.

[0046] In this case, the macro layer must not transmit the basic downlink signals/channels above (PSS/SSS, PBCH, CRS, PDCCH, etc.) on f2 in order to avoid interference to UEs that are accessing the pico layer and that may be in a location where signals from the macro layer are received with much higher power, even though the path loss to the pico layer is substantially smaller. Rather, similar to case 2, the corresponding resource elements should be empty. Thus, legacy UEs can only access the macro layer on f1 while Rel-10 UEs can be scheduled in the macro layer on both f1 and f2. It should be noted that a UE can only be scheduled on the macro layer on f2 in such a way that it does not cause any severe interference to the pico cell, either because there is no UE being scheduled on the corresponding resource in any pico cell under the coverage area of the macro cell or by using low power for the macro-cell transmission.

[0047] Note that, in the case where all pico cells are relatively far from the macro-cell site, the macro-cell site can be configured to also transmit the basic control signals/channels (with reduced power on f2). However, this would make the macro-cell on f2 appear as a separate pico cell (located at the same point as the macro cell on f1).

### Synchronization in Carrier Aggregation Systems:

[0048] Carrier aggregation in LTE Rel-10 is limited to aggregate backwards compatible component carriers, i.e. each component carrier carries basic signals like PSS/SSS, CRS, etc. However, as explained in the pre-

vious section even though these signals may be present they can be transmitted with zero/reduced power. Transmitting with zero power means the resource elements for synchronization such as PSS/SSS, CRS, etc are reserved but modulated with zero power.

[0049] In future releases even non-backwards compatible component carriers may be aggregated and such carriers may not transmit PSS/SSS, CRS, etc at all. In other words, resource elements for synchronization signals may be omitted from some component carriers according to some embodiments of the present invention.

[0050] PSSS/SSS and CRS can be used at the terminal to obtain synchronization.

### Time-Alignment:

[0051] Depending upon whether all component carriers are transmitted from the same site the received carriers may or may not be time-aligned. For example, if two or more component carriers are transmitted from the same site and are time-aligned at the transmission side, they will also be time-aligned at reception. In case of intra-band carrier aggregation, tight requirements (i.e. within a fraction of the cyclic prefix) with respect to time-alignment should occur in order to maintain orthogonality. For inter-band carrier aggregation, orthogonality is already obtained due to the separation in frequency, so that no such tight time-alignment requirements are needed.

[0052] However, when two or more component carriers are transmitted from different sites, configuring the sites to operate with co-alignment at their transmitters does not guarantee time-alignment at reception. For example, Figure 8 shows a Remote Radio Head (RRH) deployment where two component carriers are time-aligned at transmission (time 0) but are no longer time-aligned at reception. Accordingly, with reference to Figure 8, although the transmissions from the macro antenna and the RRH antenna are time aligned at transmission, terminal UE1 is located closer to the RRH antenna than to the macro antenna and, therefore, it receives the RRH antenna transmission before it receives the macro antenna transmission. In contrast, terminal UE2 is located closer to the macro antenna than to the RRH antenna and, therefore, it receives the macro antenna transmission before it receives the RRH antenna transmission. Thus, when terminals will receive signals from multiple transmitter locations, time alignment of the received signals cannot be assumed by the terminal.

### Potential Problems With Various Potential Signaling Synchronization Approaches:

[0053] Typically the terminal uses PSS/SSS and/or CRS to synchronize. In Rel-10 and later releases certain component carriers may not contain such synchronization signals or only contain synchronization signals with zero/reduced power, thus making synchronization using synchronization signals of those component carriers dif-

ficult or impossible.

**[0054]** Depending on the deployment scenario (common origin of component carriers vs. RRH) component carriers may be time-aligned or not. Since a terminal may not know in which scenario it is operating, time-alignment of component carriers cannot be assumed, thereby making it potentially impossible to blindly re-use the synchronization status of another component carrier.

**[0055]** Synchronization of component carriers can be achieved by relating (e.g., correlating) the received carrier signal with the PSS/SSS and/or the CRS. However, when these signals are not present the terminal may be unable to achieve synchronization in that manner.

#### **Operations and Methods of Various Embodiments of the Present Invention:**

**[0056]** In accordance with various embodiments of the present invention, synchronization can be carried out in a carrier aggregation system when component carriers are not transmitting or are transmitting with zero/reduced power PSS/SSS, CRS, etc. In some situations, the transmission power of PSS/SSS and CRS on one CC may need to be reduced (or even set to zero) or eliminated in order to protect the corresponding signals transmitted from another node. Moreover, component carrier types according to future specification may not even contain PSS/SSS and CRS. In other words, resource elements for synchronization signals may be omitted from some component carriers according to some embodiments of the present invention. In other situations, a component carrier may include synchronization signals, but due to strong interference from other cells, synchronization signals (e.g., PSS/SSS and/or CRS) may be difficult or impossible to receive.

**[0057]** In accordance with various embodiments of the present invention, the RAN communicates to a terminal whether it should perform individual synchronization of a component carrier using signals such as PSS/SSS/CRS on that component carrier or instead should perform aided synchronization, relying (partially) on the timing and frequency of another component carrier.

**[0058]** Before describing these embodiments, various further terminology used herein will be defined. As used herein, "individual synchronization" refers to operations and methods performed by a terminal to synchronize to a component carrier that provides signals needed for synchronization. In Rel-8/9, the individual synchronization signals can include PSS/SSS and/or CRS.

**[0059]** As used herein, "aided synchronization" refers to operations and methods performed by a terminal to synchronize to a component carrier that does not provide all signals (or provides the signals but with insufficient power) required for individual synchronization. Thus, in order to synchronize one component carrier, the terminal obtains aid from another component carrier. In one embodiment, the synchronization status (time and/or fre-

quency) are re-used from another component carrier.

**[0060]** As used herein, "Synchronization Master Component Carrier (SMCC)" refers to a component carrier that enables individual synchronization.

5 **[0061]** As used herein, "Synchronization Slave Component Carrier (SSCC)" refers to a component carrier that relies on aided synchronization.

**[0062]** As used herein, "Synchronization Master Component Carrier List (SMCCL)" refers to a list (SMCCL) that identifies all SMCC that can be used to synchronize the SSCC. This list is specific for an SSCC, so another SSCC may have a different SMCCL.

10 **[0063]** As used herein, "Synchronization Slave Component Carrier List (SSCCL)" refers to a list that identifies all SSCC that can use a SMCC for aided synchronization. This list is specific for an SMCC, so another SMCC may have a different SSCCL.

**[0064]** In accordance with some embodiments, synchronization of component carriers is facilitated by the network notifying the terminal as to whether it should perform individual synchronization of the component carrier or should instead perform aided synchronization.

**[0065]** As will be explained in further detail below, a RAN can be configured to identify one or more CCs containing signals that can be used for synchronization by a terminal. The RAN can generate a SMCCL and/or a SSCCL based on the one or more identified CCs and can communicate the generated SMCCL and/or SSCCL to the terminal. A terminal can be correspondingly configured to receive an instruction from a RAN to add a CC and can determine whether a SMCCL and/or a SSCCL corresponding to the added CC resides in the terminal, and can perform synchronization with respect to the added CC responsive to that determination.

25 **[0066]** In accordance with first embodiments of the present invention, the RAN includes processor circuitry that is configured to identify to a terminal an SMCCL that is to be used for synchronization. For example, the terminal may be notified that component carrier n (SSCC) should perform aided synchronization using component carrier k (SMCC) identified in the SMCCL. If no SMCCL list has been provided to the terminal, then the terminal may be configured to carry out a default action for synchronization. The default action can include performing individual synchronization, where the component carrier actually does not rely on aided synchronization, or a default component carrier can be used for aided synchronization.

**[0067]** When there is only one SMCC, e.g. the PCC, the SMCCL can be defined by a single bit indicating whether individual synchronization or aided synchronization is to be performed by the terminal. When aided synchronization is to be performed, a single SMCC is used. If no SMCCL is provided, the terminal can be configured to carry out a default synchronization action.

50 **[0068]** Figure 9 is a flowchart of exemplary operations 900 and methods that may be carried out by a RAN (e.g., by control processor circuitry) to notify one or more ter-

minals (UEs) of a SMCC that should be used for synchronization of a SSCC. It to be understood that one or more of the illustrated operations 900 may be omitted from at least some embodiments of the present invention.

[0069] In the RAN, implementation of this embodiment can include, with reference to Figure 9, configuring the eNB (e.g., via control processor circuitry) to initiate a process at Block 910 to determine SMCC candidates for SSCC synchronization by a terminal(s) responsive to, for example, terminal acquisition of a cell and/or assignment of a new CC to a terminal. The eNB can access a local database at Block 920 that contains information, such as that identified below, that can be used to generate a SMCCCL as described herein. The eNB determines at Block 930 which downlink component carriers contain signals that can be used by a terminal for synchronization. A further determination at Block 940 is made as to which downlink component carriers will be time-aligned when received at the terminal, where that determination can include determining time-alignment of a RRH relative to common origin and transmission time.

[0070] For example the, control processor circuitry can be configured to access a database residing at the eNB that identifies SMCCs that are candidates for use by a terminal for synchronization of one or more SSCCs. Which SMCC(s) are preferably used by the terminal may be identified based on which component carriers contain signals that can be used by the terminal for synchronization, which component carriers are transmitted from a same transmission site (i.e., which component carriers are time aligned at transmission and/or having a known timing offset and will remain aligned or with the known timing offset when received by the terminal), which component carriers are transmitted from different transmission sites, and/or which component carriers a terminal is configured with.

[0071] Channel quality conditions that may affect one or more of the candidate SMCCs may also be determined at Block 950 (e.g., received signal strength of one or more CCs measured at the terminal). The candidate SMCCs may be alternatively or additionally evaluated based on other predetermined or dynamically determined characteristics that can affect the ability of the terminal to use a component carrier for synchronization.

[0072] The RAN generates at Block 960 the SMCCCL based on these determinations, and may generate one SMCCCL that is common for all SSCCs or may generate different SMCCCLs for the different SSCCs.

[0073] Once the SMCCCL(s) are generated, the RAN communicates at Block 970 the SMCCCL to one or more terminals which associate the received SMCCCL with the SSCC. The RAN can transmit the SMCCCL with dedicated signaling to the terminal and/or can distribute the SMCCCL via broadcast. When the SMCCCL is broadcasted, a terminal may receive the SMCCCL before it is instructed to add the CC which is associated with the SMCCCL. If dedicated signaling is used, the SMCCCL may be part of the message instructing a terminal (UE) to add a new CC or

the SMCCCL may be transmitted in another message.

[0074] Figure 10 is a flowchart of exemplary operations 1000 and methods that may be carried out by a terminal (UE) to perform aided synchronization or individual synchronization. It to be understood that one or more of the illustrated operations 1000 may be omitted from at least some embodiments of the present invention.

[0075] Referring to Figure 10, a terminal responds at Block 1010 to instructions from a RAN to add a component carrier by determining at Block 1020 whether it has also received a corresponding SMCCCL, which may have been received via dedicated signaling and/or broadcast from the RAN. When the SMCCCL is received via broadcast, the terminal may receive the SMCCCL before it is instructed to add the CC which is associated with the SMCCCL. If dedicated signaling is used, the SMCCCL may be received as part of the message instructing the terminal (UE) to add a new CC or the SMCCCL may be received in another message. When the terminal determines that it has a SMCCCL associated with a SSCC, the terminal will then perform aided synchronization for the SSCC using a SMCC that is identified by the SMCCCL at Block 1030. In contrast, when the terminal determines that it has not received a SMCCCL that corresponds to a SSCC at Block 1040, the terminal may perform a default synchronization action. The default synchronization action can include performing individual synchronization, where the terminal performs synchronization to the component carrier without relying upon aid from another component carrier, or a default component carrier can be used for aided synchronization. For example, when a terminal has previously been assigned first and second CCs, the terminal may then be further assigned a third CC and notified, via the SMCCCL, to use the first CC or second CC (either one serving as a SMCC) for aided synchronization to the third CC (serving as a SSCC).

[0076] In accordance with second embodiments of the present invention, an SSCCL is provided for carriers that allow individual synchronization. The SSCCL contains a list that identifies SSCCs that can use an associated SMCC for aided synchronization.

[0077] Figure 11 is a flowchart of exemplary operations 1100 and methods that may be carried out by a RAN (e.g., by control processor circuitry) to notify one or more terminals (UEs) of a SSCCL.

[0078] In the RAN, implementation of this embodiment can include, with reference to Figure 11, configuring the eNB to initiate a process at Block 1110 to notify a terminal of a SSCCL responsive to, for example, terminal acquisition of a cell and/or assignment of a new CC to a terminal. The eNB can access a local database at Block 1120 that contains information, such as that identified below, that can be used to generate the SSCCL as described herein.

[0079] The eNB determines at Block 1130 which downlink component carriers contain signals that can be used by a terminal for synchronization. A further determination at Block 1140 is made as to which downlink component

carriers will be time-aligned when received at the terminal, where that determination can include determining time-alignment of a RRH relative to common origin and transmission time.

**[0080]** For example, control processor circuitry can be configured to access a database residing at the eNB that identifies SMCCs that are candidates for use by a terminal for synchronization of one or more SSCCs. Which SMCC(s) are preferably used by the terminal may be identified based on which component carriers contain signals that can be used by the terminal for synchronization, which component carriers are transmitted from a same transmission site (i.e., which component carriers are time aligned at transmission and/or have a known timing offset and will remain aligned or with the known timing offset when received by the terminal), and/or which component carriers are transmitted from different transmission sites.

**[0081]** Channel quality conditions that may affect one or more of the candidate SMCCs may also be determined at Block 1150 (e.g., received signal strength of one or more CCs measured at the terminal), and/or based on other predetermined or dynamically determined characteristics that can affect the ability of the terminal to use a component carrier for synchronization.

**[0082]** The RAN generates at Block 1160 the SSCCL based on these determinations, and may generate one SSCCL that is common for all SMCCs or may generate different SSCCL for the different SMCCs.

**[0083]** Once the SSCCL(s) are generated, the RAN communicates at Block 1170 the SSCCL to a terminal which associates the received SSCCL with the SMCC. The RAN can transmit the SSCCL with dedicated signaling to the terminal and/or can distribute the SSCCL via broadcast. When the SSCCL is broadcasted, a terminal may receive the SSCCL before it is instructed to add the SMCC which is associated with the SSCCL. If dedicated signaling is used, the SSCCL may be part of the message instructing a terminal (UE) to add the SMCC the SSCCL is associated with or the SMCCCL may be (part of) another message.

**[0084]** Figure 12 is a flowchart of exemplary operations 1000 and methods that may be carried out by a terminal (UE) to perform aided synchronization or individual synchronization. Referring to Figure 12, a terminal responds at Block 1210 to instructions from a RAN to add a component carrier by determining at Block 1220 whether it has also received a SSCCL, which may have been received via dedicated signaling and/or broadcast from the RAN and which contains the currently added component carrier.

**[0085]** When the SSCCL is received via broadcast, the terminal may receive the SSCCL before it is instructed to add the SMCC which is associated with the SSCCL. If dedicated signaling is used, the SSCCL may be received as part of the message instructing the terminal (UE) to add the SMCC the SSCCL is associated with or the SMCCCL may be received in another message. When

the terminal determines that it has a SSCCL associated with a SMCC, the terminal will then perform aided synchronization for the currently added component carrier using the SMCC the SSCCL belongs to at Block 1230.

**[0086]** In contrast, when the terminal determines that it does not possess a SSCCL that contains the currently added component carrier at Block 1240, the terminal may perform a default synchronization action. The default synchronization action can include assuming that the currently added component carrier is an SMCC and performing individual synchronization using the currently added component carrier. In this case the terminal also checks if the currently added SMCC has an SSCCL associated with it.

**[0087]** According to an alternate embodiment, an additional flag is included in an "add component carrier" command that is sent from the RAN to the terminal. This flag indicates whether the terminal should perform aided synchronization or not, independent of whether the terminal possesses an SSCCL that includes the currently added component carrier. In other words, this flag overwrites a potentially stored SSCCL. Accordingly, although the terminal may have an SSCCL that includes the currently added component carrier, when the flag is set the terminal performs default synchronization, e.g. individual synchronization.

**[0088]** How the SMCCCL and/or SSCCL lists are developed can depend upon, for example, the deployment scenario (i.e., whether the component carriers are transmitted from a common transmission site origin or are transmitted from multiple transmission sites, e.g., RRH) and whether the network transmits channels on a component carrier that enables individual synchronization. Since these dependencies are rather static, using a semi-static signaling protocol, e.g. RRC signaling, may provide certain advantages. Moreover, because these SMCCCL and/or SSCCL lists are optional, in that they are not needed in all deployment scenarios, optional RRC Information Elements can be defined for SMCCCL and SSCCL.

**[0089]** In this manner, various embodiments of the present invention can enable a terminal to perform synchronization in different deployment scenarios. The network performs various signaling that instruct the terminal to perform individual synchronization or to rely on aided synchronization. In the absence of these operational embodiments which enable terminal synchronization where it would not otherwise be possible, a terminal may either not be able to perform network access or may perform network access in a sub-optimum manner. Such sub-optimum network access could include not being able to optimally utilize network resources, dropping communication connections, etc.

**[0090]** To avoid these potential problems, the network could either forbid miss-alignment of received component carriers or forbid transmission of PSS/SSS, CRS, etc with reduced power. However, forbidding miss-alignment of received component carriers could prevent deployment of RRHs and/or significantly increase the op-

erational complexity of that deployment. Forbidding transmission of PSS/SSS, CRS, etc with reduced/zero power could make HetNet deployment sub-optimum. Since both deployment scenarios can be important for future network deployments, these two approaches are likely not feasible approaches.

**[0091]** Figure 13 is a block diagram of a portion of a network node 1300 and UEs 110-1 to 110-L that are configured according to some embodiments of the present invention. The network node 1300 may be provided as one or more of the radio base station nodes (eNodeBs) of Figure 1. Referring to Figure 13, the network node 1300 includes a resource scheduler 1330 that can include a resource element assignment processor 1332 and database 1334. The assignment processor 1332 may include one or more data processing and memory circuits, such as a general purpose and/or special purpose processor (e.g., microprocessor and/or digital signal processor) with on-board and/or separate memory device. The assignment processor 1332 is configured to execute computer program instructions from a memory device, described below as a computer readable medium, to assign component carriers to the UEs 110-1 to 110-L and communicate those assignments thereto. Moreover, the assignment processor 1332 is configured to execute computer program instructions from a memory device to perform one or more of the operations 900 of Figure 9 and/or one or more of the operations 1100 of Figure 11. The database 1334 contains information, such as the information described above regarding Embodiment 1 and/or Embodiment 2, that can be used by the assignment processor 1332 to generate SMCCs and/or SSCCLs for communication to the UEs 110-1 to 110-L.

**[0092]** The network node 1300 includes RF circuitry 1320 having a plurality of transceivers (TX/RX) 1322-1 to 1322-x that communicate using different frequency subcarriers through antennas 1324a-n to provide the exemplary multiple carrier portion of the resource grid shown in Figure 2. Although an exemplary one-to-one mapping of transceivers to antennas is shown, it is to be understood that any number of antennas and/or transceivers may be used depending upon antenna configuration and design constraints.

**[0093]** The network node 1300 can be configured to receive channel quality (CQ) reports and uplink (UL) buffer status reports from the UEs 110-1 to 110-L. The uplink buffer status reports can indicate how many data bits the corresponding UE has buffered awaiting uplink transmission to the RAN 1300, and can be used by the assignment processor 1332 to identify which UEs require assignment of resource elements and determine how many resource elements to assign to those UEs.

**[0094]** The CQ reports can indicate instantaneous downlink channel quality in both time and frequency domain. The CQ reports can be used by the assignment processor 1332, for example, as described above for Block 950 of Figure 9 and Block 1150 of Figure 11.

**[0095]** The network node 1300 can also include a plu-

ality of radio link control (RLC) protocol buffers 1310-1 to 1310-M where downlink data that is received from the core network 130, via the interface (I/F) 1340, is buffered awaiting transmission to addressed UEs. The assignment processor 1332 can use RLC Buffer information to identify which UEs require assignment of resource elements and determine how many resource elements to assign to those UEs.

**[0096]** Each of the UEs 110-1 to 110-L may include a processor 1312 and database 1314. The processor 1312 may include one or more data processing and memory circuits, such as a general purpose and/or special purpose processor (e.g., microprocessor and/or digital signal processor) with on-board and/or separate memory device. The processor 1312 is configured to execute computer program instructions from a memory device, described below as a computer readable medium, to perform aided synchronization or individual synchronization according to at least some of the operations 1000 of Figure 10 and/or at least some of the operations 1200 of Figure 12. The database 1314 can contain a listing of component carriers that have been assigned to the UE by the assignment processor 1332 and contain a listing of associated SMCC(s) and/or SSCCL(s) as explained above.

**[0097]** Figure 14 is a flow chart illustrating operations of a network node 1300 of Figure 13, Figure 15 is a flow chart illustrating operations of a wireless terminal (such as user equipment 110-1 of Figure 13), and taken together, Figures 14 and 15 illustrate operations of network node 1300 and user equipment providing signal synchronization according to some embodiments of the present invention. Operations of network node 1300 and user equipment 110-1 will first be discussed together with reference to Figures 14 and 15 to show interactions therebetween. Operations of Figures 14 and 15 will then be discussed separately to clarify the separate operations performed by network node 1300 and user equipment 110-1.

**[0098]** In particular, RF circuitry 1320 of network node 1300 may be configured to transmit an SMCC (Synchronization Master Component Carrier) including synchronization signals at Block 1410 on a first frequency. The synchronization signals, for example, may include Primary Synchronization Channel signals, Secondary Synchronization Channel signals, and/or Cell Specific Reference signals transmitted in periodic resource elements of the SMCC. According to some embodiments of the present invention, the SMCC may be configured and/or assigned as a downlink from RF circuitry 1320 to user equipment 110-1 before being used by user equipment 110-1 to synchronize an SSCC on a different frequency. The SMCC, however, is not required to serve as a downlink to user equipment 110-1 before being used by user equipment to synchronize an SSCC.

**[0099]** Resource scheduler 1330 may make a determination to add an SSCC (Synchronization Slave Component Carrier) on a second frequency (different than the

first frequency) to user equipment 110-1 at Block 1420. Moreover, resource scheduler 1330 may relate one or more SMCC(s) (including the transmitted SMCC on the first frequency) with the assigned SSCC on the second frequency, and/or resource scheduler 1330 may relate one or more SSCC(s) (including the assigned SSCC on the second carrier) with the transmitted SMCC on the first carrier at Block 1430. As discussed above, this information relating SMCC(s) and SSCC(s) may be: a Synchronization Slave Component Carrier List (SSCCL) that identifies all SSCC(s) (including the SSCC on the second frequency to be added) that can use the transmitted SMCC on the first frequency for aided synchronization; or a Synchronization Master Component Carrier List (SMCCL) that identifies all SMCC(s) (including the transmitted SMCC on the first frequency) that can be used to synchronize the SSCC on the second frequency to be added.

**[0100]** The information (e.g., SSCCL and/or SMCCL) relating the transmitted SMCC on the first frequency with the SSCC to be added on the second frequency may be transmitted/received to/at user equipment 110-1 at Blocks 1440 and 1510. More particularly, the information relating the transmitted SMCC and the SSCC to be added may be intended to be used for synchronization by user equipment 110-1 upon addition of the SSCC. In addition, a command to add/configure the SSCC on the second frequency as a downlink may be transmitted/received to/at user equipment 110-1 at Blocks 1450 and 1520.

**[0101]** By relating SMCC(s) with SSCC(s) at Block 1430 for the particular user equipment 110-1 after the determination to add/configure the SSCC to/for user equipment 110-1 at Block 1420, resource scheduler 1330 may dynamically relate SMCC(s) with SSCC(s) for specific user equipment 110-1 based in part on a current location of user equipment 110-1, current signal strength/quality received at/from user equipment 110-1, time delays of signals received at/from user equipment 110-1, etc. According to some embodiments, resource scheduler 1330 may relate SMCC(s) and SSCC(s) transmitted from the same or different network nodes/antennas provided that the related SMCC(s) and SSCC(s) are time aligned at user equipment 110-1. With dynamic relation of SMCC(s)/SSCC(s), for example, the information relating SMCC(s)/SSCC(s) may be transmitted at Block 1440 before, after, and/or concurrently with the command to add/configure the SSCC at Block 1450 provided that the information is provided before user equipment 110-1 synchronizes the SSCC.

**[0102]** While Figures 14 and 15 illustrate a particular order of operations of Blocks 1410, 1420, 1430, 1440, 1450, 1510, and 1520 according to some embodiments of the present invention, other orders of operations may be provided according to other embodiments of the present invention. Resource scheduler 1330, for example, may statically relate SMCC(s) with SSCC(s) based on a location from which the SMCC(s) and SSCC(s) are transmitted. Stated in other words, resource scheduler 1330 may relate SMCC(s) with SSCC(s) that are trans-

mitted from a same antenna/location, because SMCC(s) and SSCC(s) transmitted from a same location may be time aligned (on reception) regardless of a location of the receiving user equipment 110-1. With statically related SMCC(s) and SSCC(s), information correlating SMCC(s) with SSCC(s) may be transmitted/received to/at user equipment 110-1 at Blocks 1440 and 1510, for example, before the determination to add the SSCC to user equipment 110-1 at Block 1420, or after the determination at Block 1420 as discussed above with respect to dynamic relation of SMCC(s)/SSCC(s).

**[0103]** According to some embodiments of the present invention, the SMCC on the first frequency may be configured and assigned as a downlink from network node 1300 to user equipment 110-1. Accordingly, transmitting the information relating the SMCC with the SSCC at Block 1440 may include transmitting the information over the SMCC to user equipment 110-1, and/or transmitting the command to add the SSCC at Block 1450 may include transmitting the command over the SMCC to user equipment 110-1. The information relating the SMCC with the SSCC, for example, may be transmitted at Block 1440 substantially concurrently with transmitting the command to add the SSCC at Block 1450 over the SMCC on the first frequency.

**[0104]** According to some embodiments of the present invention, transmitting the information relating the SMCC with the SSCC at Block 1440 may include broadcasting the information over a third frequency that is different than the first frequency of the SMCC and different than the second frequency of the SSCC. Such broadcast information may be made available for all user equipment 110 within range of the broadcast. Accordingly, the broadcast information relating SMCC(s) with SSCC(s) may be statically determined based on locations/antennas from which the SMCC(s) and SSCC(s) are transmitted.

**[0105]** Responsive to receiving the information relating SMCC(s) with SSCC(s) at Block 1510 and responsive to receiving the command to add the SSCC at Block 1520, user equipment 110-1 may synchronize and/or configure the SSCC on the second frequency using synchronization signals from the related SMCC on the first frequency at Block 1530. By relating the added SSCC on the second frequency with a time aligned SMCC on the first frequency, user equipment 110-1 may synchronize the added SSCC without requiring any synchronization signals to be provided/received over the SSCC. Accordingly, the SSCC may be transmitted without synchronization signals (e.g., the SSCC may be transmitted with synchronization resource elements that are reserved but modulated with zero/low power, the SSCC may actually be transmitted without synchronization signals, or the SSCC may be transmitted without resource elements for synchronization signals).

**[0106]** User equipment 110-1 may transmit an acknowledgement to network node 1300 at Block 1540 indicating that the SSCC on the second frequency has

been synchronized and/or configured at user equipment 110-1, and the acknowledgement may be received by network node 1300 Block 1460. Once the SSCC has been configured at Blocks 1460 and 1540, resource scheduler 1330 may dynamically assign resource elements of the configured SSCC at Block 1470 to provide downlink data transmission over the dynamically assigned resource elements 1490. Accordingly, user equipment 110-1 may receive the downlink data transmissions at Block 1550 using the dynamically assigned resource elements of the configured SSCC.

**[0107]** User equipment 110-1 may use the synchronization signals from the related SMCC for the SSCC, for example, because: the SSCC may be transmitted without synchronization signals (e.g., the SSCC may be transmitted with synchronization resource elements that are reserved but modulated with zero/low power, the SSCC may actually be transmitted without synchronization signals, or the SSCC may be transmitted without resource elements for synchronization signals); and/or synchronization signals of the SSCC may be subject to interference from a different network node/antenna transmitting on the same frequency as the SSCC.

**[0108]** In addition, network node 1300 may be configured to transmit a flag with the command to add/configure the SSCC at Block 1450 to user equipment at Block 1520, and the flag may have one of a first value and a second value. The first value may instruct user equipment 110-1 to synchronize and/or configure the second carrier using the synchronization signals of the first carrier as discussed above at Blocks 1440, 1450, 1460, 1520, 1530, and 1540. The second value may instruct user equipment 110-1 to synchronize and/or configure SSCC according to a default synchronization without using the synchronization signals of SMCC. Accordingly, user equipment 110-1 may be configured to synchronize and/or configure the second carrier 1503 using the synchronization signals of the first carrier responsive to receiving the flag having the first value and synchronizing and/or configuring the second carrier 1503 without using the synchronization signals of the first carrier responsive to receiving the flag having the second value.

**[0109]** By way of example, a Primary Component Carrier (PCC) on a third frequency (different than the first and second frequencies of the SMCC and the SSCC) may be configured as a downlink carrier for transmissions from network node 1300 to user equipment 110-1, and the PCC may be configured before the command (to add/configure the SSCC) is transmitted/received to/at user equipment 110-1 at Blocks 1450 and 1520. Responsive to receiving the flag having the first value, user equipment 110-1 may synchronize and/or configure the SSCC on the second frequency using the synchronization signals of the related SMCC on the first frequency. Responsive to receiving the flag having the second value, user equipment 110-1 may be configured to synchronize and/or configure the SSCC on the second frequency using synchronization signals of the PCC on the third frequency.

quency.

**[0110]** According to other embodiments of the present invention, the command to add/configure the SSCC may be transmitted using a carrier on a third frequency (different than the first and second frequencies of the SMCC and the SSCC). Responsive to receiving the flag having the first value, user equipment 110-1 may synchronize and/or configure the SSCC on the second frequency using the synchronization signals of the related SMCC on the first frequency. Responsive to receiving the flag having the second value, user equipment 110-1 may synchronize and/or configure the SSCC on the second frequency using synchronization signals of the third carrier on the third frequency. In other words, user equipment 110-1 may use synchronization signals of the carrier used to transmit the command to synchronize and/or configure the SSCC.

**[0111]** According to yet other embodiments of the present invention, user equipment 110-1 may be configured to synchronize and/or configure the SSCC on the second frequency using the synchronization signals of the related SMCC on the first frequency responsive to receiving the flag having the first value. Responsive to receiving the flag having the second value, user equipment 110-1 may synchronize and/or configure the SSCC on the second frequency using synchronization signals of the SSCC on the second frequency. In other words, the second value of the flag may prompt user equipment 110-1 to synchronize and/or configure the SSCC using its own synchronization signals. For example, the SSCC may be transmitted with synchronization resource elements that are modulated with low power, and resource scheduler 1330 may transmit the flag having the second value when user equipment 110-1 is sufficiently near network node 1300 and/or subject to sufficiently low interference that the low power synchronization signals can be received and used.

**[0112]** Once user equipment 110-1 receives a command to add/configure a new SSCC, user equipment 110-1 may immediately time/frequency synchronize the SSCC using the synchronization signals of the related SMCC responsive to receiving the command, or user equipment 110-1 may wait to receive an activation command before time/frequency synchronizing the SSCC using the synchronization signals of the related SMCC (responsive to receiving the activation command). Once user equipment 110-1 time/frequency synchronizes the added SSCC, user equipment 110-1 may monitor a control channel (e.g., a Physical Downlink Control Channel or PDCCH) for the added SSCC for downlink assignments (used by resource scheduler 1330 to assign SSCC resource elements for downlink data transmissions). Responsive to receiving a downlink assignment for the added SSCC from resource scheduler 1330, user equipment 110-1 may receive downlink data transmissions from network node 1300 over the assigned resource elements of the SSCC.

**[0113]** Operations of network node 1300 will now be

discussed separately with respect to the flow chart of Figure 14 to clarify operations thereof. RF circuitry 1320 of network node 1300 may be configured to transmit an SMCC (Synchronization Master Component Carrier) including synchronization signals at Block 1410 on a first frequency. The synchronization signals, for example, may include Primary Synchronization Channel signals, Secondary Synchronization Channel signals, and/or Cell Specific Reference signals transmitted in periodic resource elements of the SMCC. According to some embodiments of the present invention, the SMCC may be configured and/or assigned as a downlink from RF circuitry 1320 to user equipment 110-1 before being used by user equipment 110-1 to synchronize an SSCC on a different frequency. The SMCC, however, is not required to serve as a downlink to user equipment 110-1 before being used by user equipment to synchronize an SSCC.

**[0114]** Resource scheduler 1330 may make a determination to add an SSCC (Synchronization Slave Component Carrier) on a second frequency (different than the first frequency) to user equipment 110-1 at Block 1420. Moreover, resource scheduler 1330 may relate one or more SMCC(s) (including the transmitted SMCC on the first frequency) with the assigned SSCC on the second frequency, and/or resource scheduler 1330 may relate one or more SSCC(s) (including the assigned SSCC on the second carrier) with the transmitted SMCC on the first carrier at Block 1430. As discussed above, this information relating SMCC(s) and SSCC(s) may be: a Synchronization Slave Component Carrier List (SSCCL) that identifies all SSCC(s) (including the SSCC on the second frequency to be added) that can use the transmitted SMCC on the first frequency for aided synchronization; or a Synchronization Master Component Carrier List (SMCCL) that identifies all SMCC(s) (including the transmitted SMCC on the first frequency) that can be used to synchronize the SSCC on the second frequency to be added.

**[0115]** The information (e.g., SSCCL and/or SMCCL) relating the transmitted SMCC on the first frequency with the SSCC to be added on the second frequency may be transmitted to user equipment 110-1 at Block 1440. More particularly, the information relating the transmitted SMCC and the SSCC to be added may be intended to be used for synchronization by user equipment 110-1 upon addition of the SSCC. In addition, a command to add/configure the SSCC on the second frequency as a downlink may be transmitted to user equipment 110-1 at Block 1450.

**[0116]** By relating SMCC(s) with SSCC(s) at Block 1430 for the particular user equipment 110-1 after the determination to add/configure the SSCC to/for user equipment 110-1 at Block 1420, resource scheduler 1330 may dynamically relate SMCC(s) with SSCC(s) for specific user equipment 110-1 based in part on a current location of user equipment 110-1, current signal strength/quality received at/from user equipment 110-1, time delays of signals received at/from user equipment 110-1, etc. According to some embodiments, resource

scheduler 1330 may relate SMCC(s) and SSCC(s) transmitted from the same or different network nodes/antennas provided that the related SMCC(s) and SSCC(s) are time aligned at user equipment 110-1. With dynamic relation of SMCC(s)/SSCC(s), for example, the information relating SMCC(s)/SSCC(s) may be transmitted at Block 1440 before, after, and/or concurrently with the command to add/configure the SSCC at Block 1450 provided that the information is provided before user equipment 110-1 synchronizes the SSCC.

**[0117]** While Figures 14 illustrates a particular order of operations of Blocks 1410, 1420, 1430, 1440, and 1450 according to some embodiments of the present invention, other orders of operations may be provided according to other embodiments of the present invention. Resource scheduler 1330, for example, may statically relate SMCC(s) with SSCC(s) based on a location from which the SMCC(s) and SSCC(s) are transmitted. Stated in other words, resource scheduler 1330 may relate SMCC(s) with SSCC(s) that are transmitted from a same antenna/location, because SMCC(s) and SSCC(s) transmitted from a same location may be time aligned (on reception) regardless of a location of the receiving user equipment 110-1. With statically related SMCC(s) and SSCC(s), information correlating SMCC(s) with SSCC(s) may be transmitted to user equipment 110-1 at Block 1440, for example, before the determination to add the SSCC to user equipment 110-1 at Block 1420, or after the determination at Block 1420 as discussed above with respect to dynamic relation of SMCC(s)/SSCC(s).

**[0118]** According to some embodiments of the present invention, the SMCC on the first frequency may be configured and assigned as a downlink from network node 1300 to user equipment 110-1. Accordingly, transmitting the information relating the SMCC with the SSCC at Block 1440 may include transmitting the information over the SMCC to user equipment 110-1, and/or transmitting the command to add the SSCC at Block 1450 may include transmitting the command over the SMCC to user equipment 110-1. The information relating the SMCC with the SSCC, for example, may be transmitted at Block 1440 substantially concurrently with transmitting the command to add the SSCC at Block 1450 over the SMCC on the first frequency.

**[0119]** According to some embodiments of the present invention, transmitting the information relating the SMCC with the SSCC at Block 1440 may include broadcasting the information over a third frequency that is different than the first frequency of the SMCC and different than the second frequency of the SSCC. Such broadcast information may be made available for all user equipment 110 within range of the broadcast. Accordingly, the broadcast information relating SMCC(s) with SSCC(s) may be statically determined based on locations/antennas from which the SMCC(s) and SSCC(s) are transmitted.

**[0120]** Upon receiving an acknowledgement from user equipment 110-1 (indicating synchronization/configura-

tion of the SSCC at user equipment 110-1) at network node 1300 at Block 1460, resource scheduler 1330 may dynamically assign resource elements of the configured SSCC at Block 1470 to provide downlink data transmission over the dynamically assigned resource elements 1490 to user equipment 110-1 at Block 1490.

**[0121]** Operations of user equipment 110-1 will now be discussed separately with respect to the flow chart of Figure 15 to clarify operations thereof.

**[0122]** In particular, the information (e.g., SSCCL and/or SMCCCL) relating the transmitted SMCC on the first frequency with the SSCC to be added on the second frequency may be received (from network node 1300) at user equipment 110-1 at Block 1510. More particularly, the information relating the transmitted SMCC and the SSCC to be added may be intended to be used by user equipment 110-1 for synchronization upon addition of the SSCC. In addition, a command to add/configure the SSCC on the second frequency as a downlink may be received (from network node 1300) at user equipment 110-1 at Block 1520.

**[0123]** While Figure 15 illustrates a particular order of operations of Blocks 1510 and 1520 according to some embodiments of the present invention, other orders of operations may be provided according to other embodiments of the present invention. With statically related SMCC(s) and SSCC(s), information correlating SMCC(s) with SSCC(s) may be received at user equipment 110-1 at Block 1510, for example, before or after network node 1300 determines to add the SSCC to user equipment 110-1.

**[0124]** According to some embodiments of the present invention, the SMCC on the first frequency may be configured and assigned as a downlink from network node 1300 to user equipment 110-1. Accordingly, receiving the information relating the SMCC with the SSCC at Block 1510 may include receiving the information over the SMCC at user equipment 110-1, and/or receiving the command to add the SSCC at Block 1520 may include receiving the command over the SMCC at user equipment 110-1. The information relating the SMCC with the SSCC, for example, may be received at Block 1510 substantially concurrently with receiving the command to add the SSCC at Block 1520 over the SMCC on the first frequency.

**[0125]** According to some embodiments of the present invention, receiving the information relating the SMCC with the SSCC at Block 1510 may include receiving a broadcast of the information over a third frequency that is different than the first frequency of the SMCC and different than the second frequency of the SSCC. Such broadcast information may be available for all user equipment 110 within range of the broadcast. Accordingly, the broadcast information relating SMCC(s) with SSCC(s) may be statically determined based on locations/antennas from which the SMCC(s) and SSCC(s) are transmitted.

**[0126]** Responsive to receiving the information relating

SMCC(s) with SSCC(s) at Block 1510 and responsive to receiving the command to add the SSCC at Block 1520, user equipment 110-1 may synchronize and/or configure the SSCC on the second frequency using synchronization signals from the related SMCC on the first frequency at Block 1530. By relating the added SSCC on the second frequency with a time aligned SMCC on the first frequency, user equipment 110-1 may synchronize the added SSCC without requiring any synchronization signals to be provided/received over the SSCC. Accordingly, the SSCC may be transmitted without synchronization signals (e.g., the SSCC may be transmitted with synchronization resource elements that are reserved but modulated with zero/low power, the SSCC may actually be transmitted with no synchronization signals, or the SSCC may be transmitted without resource elements for synchronization signals).

**[0127]** User equipment 110-1 may transmit an acknowledgement to network node 1300 at Block 1540 indicating that the SSCC on the second frequency has been synchronized and/or configured at user equipment 110-1. Once the SSCC has been configured at Block 1460, resource scheduler 1330 may dynamically assign resource elements of the configured SSCC to provide downlink data transmission over the dynamically assigned resource elements 1490. Accordingly, user equipment 110-1 may receive the downlink data transmissions at Block 1550 using the dynamically assigned resource elements of the configured SSCC. User equipment 110-1 may use the synchronization signals from the related SMCC for the SSCC, for example, because: the SSCC may be transmitted without synchronization signals (e.g., the SSCC may be transmitted with synchronization resource elements that are reserved but modulated with zero/low power, the SSCC may actually be transmitted with no synchronization signals, or the SSCC may be transmitted without resource elements for synchronization signals); and/or synchronization signals of the SSCC may be subject to interference from a different network node/antenna transmitting on the same frequency as the SSCC.

**[0128]** In the above-description of various embodiments of the present invention, it is to be understood that the terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of this specification and the relevant art and will not be interpreted in an idealized or overly formal sense expressly so defined herein.

**[0129]** When an element is referred to as being "connected", "coupled", "responsive", or variants thereof to another element, it can be directly connected, coupled, or responsive to the other element or intervening ele-

ments may be present. In contrast, when an element is referred to as being "directly connected", "directly coupled", "directly responsive", or variants thereof to another element, there are no intervening elements present. Like numbers refer to like elements throughout. Furthermore, "coupled", "connected", "responsive", or variants thereof as used herein may include wirelessly coupled, connected, or responsive. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. Well-known functions or constructions may not be described in detail for brevity and/or clarity. The term "and/or" includes any and all combinations of one or more of the associated listed items.

**[0130]** As used herein, the terms "comprise", "comprising", "comprises", "include", "including", "includes", "have", "has", "having", or variants thereof are open-ended, and include one or more stated features, integers, elements, steps, components or functions but does not preclude the presence or addition of one or more other features, integers, elements, steps, components, functions or groups thereof. Furthermore, as used herein, the common abbreviation "e.g.", which derives from the Latin phrase "exempli gratia," may be used to introduce or specify a general example or examples of a previously mentioned item, and is not intended to be limiting of such item. The common abbreviation "i.e.", which derives from the Latin phrase "id est," may be used to specify a particular item from a more general recitation.

**[0131]** Exemplary embodiments are described herein with reference to block diagrams and/or flowchart illustrations of computer-implemented methods, apparatus (systems and/or devices) and/or computer program products. It is understood that a block of the block diagrams and/or flowchart illustrations, and combinations of blocks in the block diagrams and/or flowchart illustrations, can be implemented by computer program instructions that are performed by one or more computer circuits. These computer program instructions may be provided to a processor circuit of a general purpose computer circuit, special purpose computer circuit, and/or other programmable data processing circuit to produce a machine, such that the instructions, which execute via the processor of the computer and/or other programmable data processing apparatus, transform and control transistors, values stored in memory locations, and other hardware components within such circuitry to implement the functions/acts specified in the block diagrams and/or flowchart block or blocks, and thereby create means (functionality) and/or structure for implementing the functions/acts specified in the block diagrams and/or flowchart block(s).

**[0132]** These computer program instructions may also be stored in a tangible computer-readable medium that can direct a computer or other programmable data processing apparatus to function in a particular manner, such that the instructions stored in the computer-readable medium produce an article of manufacture including

instructions which implement the functions/acts specified in the block diagrams and/or flowchart block or blocks.

**[0133]** A tangible, non-transitory computer-readable medium may include an electronic, magnetic, optical, electromagnetic, or semiconductor data storage system, apparatus, or device. More specific examples of the computer-readable medium would include the following: a portable computer diskette, a random access memory (RAM) circuit, a read-only memory (ROM) circuit, an erasable programmable read-only memory (EPROM or Flash memory) circuit, a portable compact disc read-only memory (CD-ROM), and a portable digital video disc read-only memory (DVD/BlueRay).

**[0134]** The computer program instructions may also be loaded onto a computer and/or other programmable data processing apparatus to cause a series of operational steps to be performed on the computer and/or other programmable apparatus to produce a computer-implemented process such that the instructions which execute on the computer or other programmable apparatus provide steps for implementing the functions/acts specified in the block diagrams and/or flowchart block or blocks.

**[0135]** Accordingly, embodiments of the present invention may be embodied in hardware and/or in software (including firmware, resident software, micro-code, etc.) that runs on a processor such as a digital signal processor, which may collectively be referred to as "circuitry," "a module" or variants thereof.

**[0136]** It should also be noted that in some alternate implementations, the functions/acts noted in the blocks may occur out of the order noted in the flowcharts. For example, two blocks shown in succession may in fact be executed substantially concurrently or the blocks may sometimes be executed in the reverse order, depending upon the functionality/acts involved. Moreover, the functionality of a given block of the flowcharts and/or block diagrams may be separated into multiple blocks and/or the functionality of two or more blocks of the flowcharts and/or block diagrams may be at least partially integrated. Finally, other blocks may be added/inserted between the blocks that are illustrated. Moreover, although some of the diagrams include arrows on communication paths to show a primary direction of communication, it is to be understood that communication may occur in the opposite direction to the depicted arrows.

**[0137]** Many different embodiments have been disclosed herein, in connection with the above description and the drawings. It will be understood that it would be unduly repetitious and obfuscating to literally describe and illustrate every combination and subcombination of these embodiments.

**[0138]** Many variations and modifications can be made to the embodiments without substantially departing from the principles of the present invention. The scope of the invention is defined by the claims.

## Claims

1. A method of providing signal synchronization for a radio access network, the method comprising transmitting (1410) a first component carrier (1410) including synchronization signals on a first frequency from the radio access network, the method **characterized by**:

transmitting (1440), to a wireless terminal (110-1), on said first component carrier, information relating the first component carrier with a second component carrier that is to be transmitted on a second frequency (1440), said information being intended to be used by said wireless terminal (110-1) upon addition of the second component carrier in synchronization and/or configuration of said second component carrier using the synchronization signals of the first component carrier, wherein the first and second frequencies are different; and transmitting (1450) a command to add the second component carrier as a downlink (1450) for transmissions to the wireless terminal (110-1), wherein transmitting the command to add the second component carrier comprises transmitting a flag having one of a first value and a second value, wherein the first value instructs the wireless terminal (110-1) to synchronize and/or configure the second component carrier using the synchronization signals of the first component carrier, and wherein the second value instructs the wireless terminal (110-1) to synchronize and/or configure the second component carrier without using the synchronization signals of the first component carrier.

2. A method according to Claim 1, wherein the first and second component carriers are time aligned.
3. A method according to Claims 1 or 2, wherein the information relating the first component carrier with the second component carrier comprises a list of a plurality of second component carriers on a respective plurality of second frequencies that are related with the first component carrier.
4. A method according to Claims 1 or 2, wherein the information relating the first component carrier with the second component carrier comprises a list identifying a plurality of first carriers on a respective plurality of first frequencies that are related with the second carrier.
5. A method according to any of Claims 1-4, wherein the first carrier is configured as a downlink to the wireless terminal (110-1), and wherein transmitting (1440) the information relating the second carrier

with the first carrier comprises transmitting the information over the first carrier to the wireless terminal (110-1).

6. A method according to any of Claims 1-5, wherein transmitting (1440) the information relating the first component carrier with the second component carrier comprises transmitting the information to the wireless terminal (110-1) with the command to add the second carrier.
7. A method according to any of Claims 1-4, wherein transmitting (1440) the information relating the first component carrier with the second component carrier comprises transmitting the information over a third frequency different than the first frequency and different than the second frequency.
8. A method according to any of Claims 1-7, further comprising:  
after transmitting the information and the command to add the second component carrier, receiving acknowledgment (1460) from the wireless terminal (110-1) indicating synchronization and/or configuration of the second component carrier at the wireless terminal (110-1); and responsive to receiving the acknowledgment, transmitting downlink data (1490) over the second component carrier to the wireless terminal (110-1).
9. A method according to any of Claims 1-8, wherein the synchronization signals are transmitted in periodic resource elements of the first component carrier.

10. A method providing signal synchronization at a wireless terminal (110-1), said wireless terminal (110-1) communicating with a radio access network that transmits a first component carrier including synchronization signals on a first frequency, the method **characterized by**

receiving (1510), on said first component carrier, from the radio access network, information (1510) relating the first component carrier with a second component carrier that is to be received on a second frequency;  
receiving (1520), from the radio access network, a command (1520) to add the second component carrier as a downlink for transmissions; and responsive to receiving the command to add the second component carrier, synchronizing and/or configuring the second component carrier (1530) on the second frequency using the synchronization signals of the first component carrier on the first frequency, wherein receiving

- (1520) the command to add the second component carrier comprises receiving a flag having one of a first value and a second value, and wherein synchronizing and/or configuring the second component carrier comprises synchronizing and/or configuring the second component carrier using the synchronization signals of the first component carrier responsive to receiving the flag having the first value and synchronizing and/or configuring the second component carrier without using the synchronization signals of the first component carrier responsive to receiving the flag having the second value.
11. A method according to Claim 10, wherein the first and second component carriers are time aligned.
  12. A method according to Claims 10 or 11, wherein the information relating the first component carrier with the second component carrier comprises a list of a plurality of second component carriers on a respective plurality of second frequencies that are related with the first component carrier.
  13. A method according to Claims 10 or 11, wherein the information relating the first component carrier with the second component carrier comprises a list identifying a plurality of first component carriers on a respective plurality of first frequencies that are related with the second component carrier.
  14. A method according to any of Claims 10-13, wherein the first component carrier is configured as a downlink from the radio access network to the wireless terminal (110-1), and wherein receiving the information relating the first component carrier with the second component carrier comprises receiving the information over the first component carrier at the wireless terminal (110-1).
  15. A method according to any of Claims 10-14, wherein receiving the information relating the first component carrier with the second component carrier comprises receiving the information at the wireless terminal (110-1) with the command to add the second component carrier.
  16. A method according to any of Claims 10-13, wherein receiving the information relating the first component carrier with the second component carrier comprises receiving the information over a third frequency different than the first frequency and different than the second frequency.
  17. A method according to Claim 16, further comprising:
 

before receiving the command, configuring a third component carrier on a third frequency as
  18. A method according to Claims 10-16, wherein the synchronization signals are transmitted by the radio access network in periodic resource elements of the first component carrier.
  19. A radio access network node (1300) comprising radio frequency circuitry (1320) configured to transmit a first component carrier including synchronization signals on a first frequency, the radio access network node **characterized by**:
 

a resource scheduler (1330) coupled to the radio frequency circuitry (1320), wherein the resource scheduler is configured to transmit, on said first component carrier, to a wireless terminal (110-1), information relating the first component carrier with a second component carrier that is to be transmitted on a second frequency through the radio frequency circuitry (1320), and to transmit a command to add the second component carrier as a downlink for transmissions to a wireless terminal (110-1), wherein the command to add the second component carrier is transmitted through the radio frequency circuitry (1320) to the wireless terminal (110-1), wherein the first and second frequencies are different, said information being intended to be used by a wireless terminal (110-1) upon addition of the second component carrier in synchronization and/or configuration of said second component carrier using the synchronization signals of the first component carrier, wherein the resource scheduler (1330) is configured to transmit the command to add the second component carrier by transmitting a flag having one of a first value and a second value, wherein the first value instructs the wireless terminal (110-1) to synchronize and/or configure the second component carrier using the synchronization signals of the first component carrier, and wherein the second value instructs the wireless terminal (110-1) to synchronize and/or configure the second component carrier without using the

synchronization signals of the first component carrier.

20. A radio access network node (1300) according to Claim 19, wherein the resource scheduler (1330) is further configured to transmit the command to add the second component carrier including a flag having one of a first value and a second value, wherein the first value instructs the wireless terminal (110-1) to synchronize and/or configure the second component carrier using the synchronization signals of the first component carrier, and wherein the second value instructs the wireless terminal (110-1) to synchronize and/or configure the second component carrier without using the synchronization signals of the first component carrier.
21. A wireless terminal (110-1) configured for communication with a radio access network (1330) that transmits a first component carrier including synchronization signals on a first frequency, the wireless terminal (110-1) **characterized by:**
- a processor (1312) configured to receive, on said first component carrier, information relating the first component carrier with a second component carrier that is to be received on a second frequency, wherein the information is received from the radio access network,
- to receive a command to add the second component carrier as a downlink for transmissions from the radio access network to the wireless terminal (110-1), and to synchronize and/or configure the second component carrier on the second frequency using the synchronization signals of the first component carrier on the first frequency responsive to receiving the command to add the second component carrier, wherein the processor (1312) is configured to receive the command to add the second component carrier by receiving a flag having one of a first value and a second value, and to synchronize and/or configure the second component carrier by synchronizing and/or configuring the second component carrier using the synchronization signals of the first component carrier responsive to receiving the flag having the first value and to synchronize and/or configure the second component carrier without using the synchronization signals of the first component carrier responsive to receiving the flag having the second value.

## Patentansprüche

- Verfahren zum Bereitstellen von Signalsynchronisation für ein Funkzugangsnetz, wobei das Verfahren umfasst: Übertragen (1410) eines ersten Komponententrägers (1410), der Synchronisationssignale aufweist, auf einer ersten Frequenz vom Funkzugangsnetz, wobei das Verfahren **gekennzeichnet ist durch:**
  - Übertragen (1440) von Information auf dem ersten Komponententräger zu einem drahtlosen Endgerät (110-1), die den ersten Komponententräger mit einem zweiten Komponententräger verknüpft, der auf einer zweiten Frequenz zu übertragen ist (1440), wobei die Information dafür vorgesehen ist, **durch** das drahtlose Endgerät (110-1) beim Hinzufügen des zweiten Komponententrägers zur Synchronisation und/oder Konfiguration des zweiten Komponententrägers unter Verwendung der Synchronisationssignale des ersten Komponententrägers verwendet zu werden, worin die erste und die zweite Frequenz sich unterscheiden; und
  - Übertragen (1450) eines Befehls, den zweiten Komponententräger als Abwärtsstrecke für Übertragungen zum drahtlosen Endgerät (110-1) hinzuzufügen (1450), worin das Übertragen des Befehls, den zweiten Komponententräger hinzuzufügen, umfasst: Übertragen eines Flags, das einen von einem ersten und einem zweiten Wert hat, worin der erste Wert das drahtlose Endgerät (110-1) anweist, den zweiten Komponententräger unter Verwendung der Synchronisationssignale des ersten Komponententrägers zu synchronisieren und/oder zu konfigurieren, und worin der zweite Wert das drahtlose Endgerät (110-1) anweist, den zweiten Komponententräger ohne Verwendung der Synchronisationssignale des ersten Komponententrägers zu synchronisieren und/oder zu konfigurieren.
- Verfahren nach Anspruch 1, worin der erste und der zweite Komponententräger zeitlich abgestimmt sind.
- Verfahren nach Anspruch 1 oder 2, worin die Information, die den ersten Komponententräger mit dem zweiten Komponententräger verknüpft, eine Liste einer Vielzahl von zweiten Komponententrägern auf einer jeweiligen Vielzahl von zweiten Frequenzen, die mit dem ersten Komponententräger verknüpft sind, umfasst.
- Verfahren nach Anspruch 1 oder 2, worin die Information, die den ersten Komponententräger mit dem zweiten Komponententräger verknüpft, eine Liste

umfasst, die eine Vielzahl von ersten Trägern auf einer jeweiligen Vielzahl von ersten Frequenzen, die mit dem zweiten Träger verknüpft sind, kennzeichnet.

5. Verfahren nach einem der Ansprüche 1 bis 4, worin der erste Träger als Abwärtsstrecke zum drahtlosen Endgerät (110-1) konfiguriert ist und worin das Übertragen (1440) der Information, die den zweiten Träger mit dem ersten Träger verknüpft, umfasst: Übertragen der Information über den ersten Träger zum drahtlosen Endgerät (110-1).

6. Verfahren nach einem der Ansprüche 1 bis 5, worin das Übertragen (1440) der Information, die den ersten Komponententräger mit dem zweiten Komponententräger verknüpft, umfasst: Übertragen der Information zum drahtlosen Endgerät (110-1) mit dem Befehl, den zweiten Träger hinzuzufügen.

7. Verfahren nach einem der Ansprüche 1 bis 4, worin das Übertragen (1440) der Information, die den ersten Komponententräger mit dem zweiten Komponententräger verknüpft, umfasst: Übertragen der Information über eine dritte Frequenz, die sich von der ersten Frequenz unterscheidet und sich von der zweiten Frequenz unterscheidet.

8. Verfahren nach einem der Ansprüche 1 bis 7, ferner umfassend:

nach dem Übertragen der Information und des Befehls, den zweiten Komponententräger hinzuzufügen, erfolgreiches Empfangen einer Bestätigung (1460) vom drahtlosen Endgerät (110-1), welche die Synchronisation und/oder Konfiguration des zweiten Komponententrägers im drahtlosen Endgerät (110-1) angibt; und als Antwort auf das Empfangen der Bestätigung erfolgreiches Übertragen von Abwärtsstreckendaten (1490) über den zweiten Komponententräger zum drahtlosen Endgerät (110-1).

9. Verfahren nach einem der Ansprüche 1 bis 8, worin die Synchronisationssignale in periodischen Ressourcenelementen des ersten Komponententrägers übertragen werden.

10. Verfahren zum Bereitstellen von Signalsynchronisation in einem drahtlosen Endgerät (110-1), wobei das drahtlose Endgerät (110-1) mit einem Funkzugangsnetz kommuniziert, welches einen ersten Komponententräger, der Synchronisationssignale aufweist, auf einer ersten Frequenz überträgt, wobei das Verfahren **gekennzeichnet ist durch:**

Empfangen (1510) von Information (1510) auf dem ersten Komponententräger vom Funkzu-

gangsnetz, die den ersten Komponententräger mit einem zweiten Komponententräger verknüpft, der auf einer zweiten Frequenz zu empfangen ist;

Empfangen (1520) eines Befehls (1520) vom Funkzugangsnetz, den zweiten Komponententräger als Abwärtsstrecke für Übertragungen hinzuzufügen; und

als Antwort auf das Empfangen des Befehls, den zweiten Komponententräger hinzuzufügen, erfolgreiches Synchronisieren und/oder Konfigurieren des zweiten Komponententrägers (1530) auf der zweiten Frequenz unter Verwendung der Synchronisationssignale des ersten Komponententrägers auf der ersten Frequenz, worin das Empfangen (1520) des Befehls, den zweiten Komponententräger hinzuzufügen, umfasst: Empfangen eines Flags, das einen von einem ersten und einem zweiten Wert hat, und worin das Synchronisieren und/oder Konfigurieren des zweiten Komponententrägers umfasst: Synchronisieren und/oder Konfigurieren des zweiten Komponententrägers unter Verwendung der Synchronisationssignale des ersten Komponententrägers als Antwort auf das Empfangen des Flags mit dem ersten Wert und Synchronisieren und/oder Konfigurieren des zweiten Komponententrägers ohne Verwendung der Synchronisationssignale des ersten Komponententrägers als Antwort auf das Empfangen des Flags mit dem zweiten Wert.

11. Verfahren nach Anspruch 10, worin der erste und der zweite Komponententräger zeitlich abgestimmt sind.

12. Verfahren nach Anspruch 10 oder 11, worin die Information, die den ersten Komponententräger mit dem zweiten Komponententräger verknüpft, eine Liste einer Vielzahl von zweiten Komponententrägern auf einer jeweiligen Vielzahl von zweiten Frequenzen, die mit dem ersten Komponententräger verknüpft sind, umfasst.

13. Verfahren nach Anspruch 10 oder 11, worin die Information, die den ersten Komponententräger mit dem zweiten Komponententräger verknüpft, eine Liste umfasst, die eine Vielzahl von ersten Komponententrägern auf einer jeweiligen Vielzahl von ersten Frequenzen, die mit dem zweiten Komponententräger verknüpft sind, kennzeichnet.

14. Verfahren nach einem der Ansprüche 10 bis 13, worin der erste Komponententräger als Abwärtsstrecke vom Funkzugangsnetz zum drahtlosen Endgerät (110-1) konfiguriert ist und worin das Empfangen der Information, die den ersten Komponententräger mit dem zweiten Komponententräger verknüpft, um-

fasst: Empfangen der Information über den ersten Komponententräger im drahtlosen Endgerät (110-1).

15. Verfahren nach einem der Ansprüche 10 bis 14, worin das Empfangen der Information, die den ersten Komponententräger mit dem zweiten Komponententräger verknüpft, umfasst: Empfangen der Information im drahtlosen Endgerät (110-1) mit dem Befehl, den zweiten Komponententräger hinzuzufügen. 5  
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16. Verfahren nach einem der Ansprüche 10 bis 13, worin das Empfangen der Information, die den ersten Komponententräger mit dem zweiten Komponententräger verknüpft, umfasst: Übertragen der Information über eine dritte Frequenz, die sich von der ersten Frequenz unterscheidet und sich von der zweiten Frequenz unterscheidet. 15  
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17. Verfahren nach Anspruch 16, ferner umfassend:  
vor dem Empfangen des Befehls erfolgreiches Konfigurieren eines dritten Komponententrägers auf einer dritten Frequenz als Abwärtsstreckenträger für Übertragungen vom Funkzugangszugangnetz; 25  
als Antwort auf das Empfangen des Flags mit dem ersten Wert erfolgreiches Synchronisieren und/oder Konfigurieren (1530) des zweiten Komponententrägers auf der zweiten Frequenz unter Verwendung der Synchronisationssignale des ersten Komponententrägers auf der ersten Frequenz; und 30  
als Antwort auf das Empfangen des Flags mit dem zweiten Wert erfolgreiches Synchronisieren und/oder Konfigurieren des zweiten Komponententrägers auf der zweiten Frequenz unter Verwendung von Synchronisationssignalen des dritten Komponententrägers auf der dritten Frequenz. 35  
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18. Verfahren nach einem der Ansprüche 10 bis 16, worin die Synchronisationssignale durch das Funkzugangszugangnetz in periodischen Ressourcenelementen des ersten Komponententrägers übertragen werden. 45
19. Funkzugangszugangsknoten (1300), umfassend Funkfrequenzschaltungen (1320), die dafür konfiguriert sind, einen ersten Komponententräger, der Synchronisationssignale aufweist, auf einer ersten Frequenz zu übertragen, wobei der Funkzugangszugangsknoten **gekennzeichnet ist durch:** 50  
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einen Ressourcenplaner (1330), der mit den Funkfrequenzschaltungen (1320) gekoppelt ist, wobei der Ressourcenplaner dafür konfiguriert

ist:

auf dem ersten Komponententräger Information zu einem drahtlosen Endgerät (110-1) zu übertragen, die den ersten Komponententräger mit einem zweiten Komponententräger verknüpft, der über die Funkfrequenzschaltungen (1320) auf einer zweiten Frequenz zu übertragen ist, und einen Befehl zu übertragen, den zweiten Komponententräger als Abwärtsstrecke für Übertragungen zu einem drahtlosen Endgerät (110-1) hinzuzufügen, worin der Befehl, den zweiten Komponententräger hinzuzufügen, über die Funkfrequenzschaltungen (1320) zum drahtlosen Endgerät (110-1) übertragen wird, worin die erste und die zweite Frequenz sich unterscheiden, wobei die Information dafür vorgesehen ist, **durch** ein drahtloses Endgerät (110-1) beim Hinzufügen des zweiten Komponententrägers zur Synchronisation und/oder Konfiguration des zweiten Komponententrägers unter Verwendung der Synchronisationssignale des ersten Komponententrägers verwendet zu werden, worin der Ressourcenplaner (1330) dafür konfiguriert ist:

den Befehl, den zweiten Komponententräger hinzuzufügen, **durch** Übertragen eines Flags zu übertragen, das einen von einem ersten und einem zweiten Wert hat, worin der erste Wert das drahtlose Endgerät (110-1) anweist, den zweiten Komponententräger unter Verwendung der Synchronisationssignale des ersten Komponententrägers zu synchronisieren und/oder zu konfigurieren, und worin der zweite Wert das drahtlose Endgerät (110-1) anweist, den zweiten Komponententräger ohne Verwendung der Synchronisationssignale des ersten Komponententrägers zu synchronisieren und/oder zu konfigurieren.

20. Funkzugangszugangsknoten (1300) nach Anspruch 19, worin der Ressourcenplaner (1330) ferner dafür konfiguriert ist, den Befehl, den zweiten Komponententräger hinzuzufügen, einschließlich eines Flags zu übertragen, das einen von einem ersten und einem zweiten Wert hat, worin der erste Wert das drahtlose Endgerät (110-1) anweist, den zweiten Komponententräger unter Verwendung der Synchronisationssignale des ersten Komponententrägers zu synchronisieren und/oder zu konfigurieren, und worin der zweite Wert das drahtlose Endgerät (110-1) anweist,

den zweiten Komponententräger ohne Verwendung der Synchronisationssignale des ersten Komponententrägers zu synchronisieren und/oder zu konfigurieren.

21. Drahtloses Endgerät (110-1), zur Kommunikation mit einem Funkzugangsnetz (1330), das einen ersten Komponententräger, der Synchronisationssignale aufweist, auf einer ersten Frequenz überträgt, wobei das drahtlose Endgerät (110-1) **gekennzeichnet ist durch:**

einen Prozessor (1312), der dafür konfiguriert ist:

auf dem ersten Komponententräger Information zu empfangen, die den ersten Komponententräger mit einem zweiten Komponententräger verknüpft, der auf einer zweiten Frequenz zu empfangen ist, worin die Information vom Funkzugangsnetz empfangen wird;

einen Befehl zu empfangen, den zweiten Komponententräger als Abwärtsstrecke für Übertragungen vom Funkzugangsnetz zum drahtlosen Endgerät (110-1) hinzuzufügen, und als Antwort auf das Empfangen des Befehls, den zweiten Komponententräger hinzuzufügen, den zweiten Komponententräger auf der zweiten Frequenz unter Verwendung der Synchronisationssignale des ersten Komponententrägers auf der ersten Frequenz zu synchronisieren und/oder zu konfigurieren, worin der Prozessor (1312) dafür konfiguriert ist:

den Befehl, den zweiten Komponententräger hinzuzufügen, **durch** Empfangen eines Flags, das einen von einem ersten und einem zweiten Wert hat, zu empfangen, und

den zweiten Komponententräger zu synchronisieren und/oder zu konfigurieren, indem als Antwort auf das Empfangen des Flags mit dem ersten Wert der zweite Komponententräger unter Verwendung der Synchronisationssignale des ersten Komponententrägers synchronisiert und/oder konfiguriert wird, und

als Antwort auf das Empfangen des Flags mit dem zweiten Wert der zweite Komponententräger ohne Verwendung der Synchronisationssignale des ersten Komponententrägers zu synchronisieren und/oder zu konfigurieren.

## Revendications

1. Procédé de fourniture de synchronisation de signal pour un réseau d'accès radio, le procédé comportant l'étape consistant à transmettre (1410) une première porteuse composante (1410) incluant des signaux de synchronisation sur une première fréquence à partir du réseau d'accès radio, le procédé étant **caractérisé par** les étapes ci-dessous consistant à :

transmettre (1440), à un terminal sans fil (110-1), sur ladite première porteuse composante, des informations associant la première porteuse composante à une deuxième porteuse composante, qui doivent être transmises sur une deuxième fréquence (1440), lesdites informations étant destinées à être utilisées par ledit terminal sans fil (110-1), suite à l'ajout de la deuxième porteuse composante, dans le cadre d'une synchronisation et/ou d'une configuration de ladite deuxième porteuse composante en utilisant les signaux de synchronisation de la première porteuse composante, dans lequel les première et deuxième fréquences sont différentes ; et

transmettre (1450) une instruction visant à ajouter la deuxième porteuse composante en tant qu'une liaison descendante (1450) pour des transmissions au terminal sans fil (110-1), dans lequel l'étape de transmission de l'instruction visant à ajouter la deuxième porteuse composante consiste à transmettre un drapeau présentant l'une parmi une première valeur et une seconde valeur, dans lequel la première valeur ordonne au terminal sans fil (110-1) de synchroniser et/ou configurer la deuxième porteuse composante en utilisant les signaux de synchronisation de la première porteuse composante, et dans lequel la seconde valeur ordonne au terminal sans fil (110-1) de synchroniser et/ou configurer la deuxième porteuse composante sans utiliser les signaux de synchronisation de la première porteuse composante.

2. Procédé selon la revendication 1, dans lequel les première et deuxième porteuses composantes sont alignées dans le temps.
3. Procédé selon la revendication 1 ou 2, dans lequel les informations associant la première porteuse composante à la deuxième porteuse composante comportent une liste d'une pluralité de deuxièmes porteuses composantes sur une pluralité respective de deuxièmes fréquences qui sont associées à la première porteuse composante.
4. Procédé selon la revendication 1 ou 2, dans lequel les informations associant la première porteuse

composante à la deuxième porteuse composante comportent une liste identifiant une pluralité de premières porteuses sur une pluralité respective de premières fréquences qui sont associées à la deuxième porteuse.

5. Procédé selon l'une quelconque des revendications 1 à 4, dans lequel la première porteuse est configurée en tant qu'une liaison descendante vers le terminal sans fil (110-1), et dans lequel l'étape de transmission (1440) des informations associant la deuxième porteuse à la première porteuse consiste à transmettre les informations sur la première porteuse au terminal sans fil (110-1). 5
6. Procédé selon l'une quelconque des revendications 1 à 5, dans lequel l'étape de transmission (1440) des informations associant la première porteuse composante à la deuxième porteuse composante consiste à transmettre les informations au terminal sans fil (110-1) avec l'instruction visant à ajouter la deuxième porteuse. 10
7. Procédé selon l'une quelconque des revendications 1 à 4, dans lequel l'étape de transmission (1440) des informations associant la première porteuse composante à la deuxième porteuse composante consiste à transmettre les informations sur une troisième fréquence, différente de la première fréquence et différente de la deuxième fréquence. 15
8. Procédé selon l'une quelconque des revendications 1 à 7, comportant en outre les étapes ci-dessous consistant à : 20
 

après avoir transmis les informations et l'instruction visant à ajouter la deuxième porteuse composante, recevoir un accusé de réception (1460) en provenance du terminal sans fil (110-1) indiquant la synchronisation et/ou la configuration de la deuxième porteuse composante au niveau du terminal sans fil (110-1) ; et 25

en réponse à la réception de l'accusé de réception, transmettre des données de liaison descendante (1490) sur la deuxième porteuse composante au terminal sans fil (110-1). 30
9. Procédé selon l'une quelconque des revendications 1 à 8, dans lequel les signaux de synchronisation sont transmis dans des éléments de ressources périodiques de la première porteuse composante. 35
10. Procédé de fourniture de synchronisation de signal au niveau d'un terminal sans fil (110-1), ledit terminal sans fil (110-1) communiquant avec un réseau d'accès radio qui transmet une première porteuse composante incluant des signaux de synchronisation sur une première fréquence, le procédé étant caracté- 40

risé par les étapes ci-dessous consistant à :

recevoir (1510), sur ladite première porteuse composante, en provenance du réseau d'accès radio, des informations (1510) associant la première porteuse composante à une deuxième porteuse composante, qui doivent être reçues sur une deuxième fréquence ;

recevoir (1520), en provenance du réseau d'accès radio, une instruction (1520) visant à ajouter la deuxième porteuse composante en tant qu'une liaison descendante pour des transmissions ; et

en réponse à la réception de l'instruction visant à ajouter la deuxième porteuse composante, synchroniser et/ou configurer la deuxième porteuse composante (1530) sur la deuxième fréquence en utilisant les signaux de synchronisation de la première porteuse composante sur la première fréquence, dans lequel l'étape de réception (1520) de l'instruction visant à ajouter la deuxième porteuse composante consiste à recevoir un drapeau présentant l'une parmi une première valeur et une seconde valeur, et dans lequel l'étape de synchronisation et/ou configuration de la deuxième porteuse composante consiste à synchroniser et/ou configurer la deuxième porteuse composante en utilisant les signaux de synchronisation de la première porteuse composante en réponse à la réception du drapeau présentant la première valeur, et à synchroniser et/ou configurer la deuxième porteuse composante sans utiliser les signaux de synchronisation de la première porteuse composante en réponse à la réception du drapeau présentant la seconde valeur. 45

11. Procédé selon la revendication 10, dans lequel les première et deuxième porteuses composantes sont alignées dans le temps. 50
12. Procédé selon la revendication 10 ou 11, dans lequel les informations associant la première porteuse composante à la deuxième porteuse composante comportent une liste d'une pluralité de deuxièmes porteuses composantes sur une pluralité respective de deuxièmes fréquences qui sont associées à la première porteuse composante. 55
13. Procédé selon la revendication 10 ou 11, dans lequel les informations associant la première porteuse composante à la deuxième porteuse composante comportent une liste identifiant une pluralité de premières porteuses composantes sur une pluralité respective de premières fréquences qui sont associées à la deuxième porteuse composante.
14. Procédé selon l'une quelconque des revendications

- 10 à 13, dans lequel la première porteuse composante est configurée en tant qu'une liaison descendante allant du réseau d'accès radio au terminal sans fil (110-1), et dans lequel l'étape de réception des informations associant la première porteuse composante à la deuxième porteuse composante consiste à recevoir les informations sur la première porteuse composante au niveau du terminal sans fil (110-1). 5
15. Procédé selon l'une quelconque des revendications 10 à 14, dans lequel l'étape de réception des informations associant la première porteuse composante à la deuxième porteuse composante consiste à recevoir les informations au niveau du terminal sans fil (110-1) avec l'instruction visant à ajouter la deuxième porteuse composante. 10
16. Procédé selon l'une quelconque des revendications 10 à 13, dans lequel l'étape de réception des informations associant la première porteuse composante à la deuxième porteuse composante consiste à recevoir les informations sur une troisième fréquence, différente de la première fréquence et différente de la deuxième fréquence. 20
17. Procédé selon la revendication 16, comportant en outre les étapes ci-dessous consistant à : 25
- avant de recevoir l'instruction, configurer une troisième porteuse composante sur une troisième fréquence en tant qu'une porteuse de liaison descendante pour des transmissions à partir du réseau d'accès radio ; 30
- en réponse à la réception du drapeau présentant la première valeur, synchroniser et/ou configurer (1530) la deuxième porteuse composante sur la deuxième fréquence en utilisant les signaux de synchronisation de la première porteuse composante sur la première fréquence ; 35
- et 40
- en réponse à la réception du drapeau présentant la seconde valeur, synchroniser et/ou configurer la deuxième porteuse composante sur la deuxième fréquence en utilisant des signaux de synchronisation de la troisième porteuse composante sur la troisième fréquence. 45
18. Procédé selon l'une quelconque des revendications 10 à 16, dans lequel les signaux de synchronisation sont transmis par le réseau d'accès radio dans des éléments de ressources périodiques de la première porteuse composante. 50
19. Noeud de réseau d'accès radio (1300) comportant des circuits de fréquence radio (1320) configurés de manière à transmettre une première porteuse composante incluant des signaux de synchronisation sur 55

une première fréquence, le noeud de réseau d'accès radio étant **caractérisé par** :

un planificateur de ressources (1330) couplé aux circuits de fréquence radio (1320), dans lequel le planificateur de ressources est configuré de manière à :

transmettre, sur ladite première porteuse composante, à un terminal sans fil (110-1), des informations associant la première porteuse composante à une deuxième porteuse composante qui doit être transmise sur une deuxième fréquence par le biais des circuits de fréquence radio (1320) ; et transmettre une instruction visant à ajouter la deuxième porteuse composante en tant qu'une liaison descendante pour des transmissions à un terminal sans fil (110-1), dans lequel l'instruction visant à ajouter la deuxième porteuse composante est transmise par le biais des circuits de fréquence radio (1320) au terminal sans fil (110-1), dans lequel les première et deuxième fréquences sont différentes, lesdites informations étant destinées à être utilisées par un terminal sans fil (110-1) lors de l'ajout de la deuxième porteuse composante dans le cadre d'une synchronisation et/ou configuration de ladite deuxième porteuse composante en utilisant les signaux de synchronisation de la première porteuse composante, dans lequel le planificateur de ressources (1330) est configuré de manière à :

transmettre l'instruction visant à ajouter la deuxième porteuse composante en transmettant un drapeau présentant l'une parmi une première valeur et une seconde valeur, dans lequel la première valeur ordonne au terminal sans fil (110-1) de synchroniser et/ou configurer la deuxième porteuse composante en utilisant les signaux de synchronisation de la première porteuse composante, et dans lequel la seconde valeur ordonne au terminal sans fil (110-1) de synchroniser et/ou configurer la deuxième porteuse composante sans utiliser les signaux de synchronisation de la première porteuse composante.

20. Noeud de réseau d'accès radio (1300) selon la revendication 19, dans lequel le planificateur de ressources (1330) est en outre configuré de manière à transmettre l'instruction visant à ajouter la deuxième porteuse composante incluant un drapeau présentant l'une parmi une première valeur et une seconde

valeur, dans lequel la première valeur ordonne au terminal sans fil (110-1) de synchroniser et/ou configurer la deuxième porteuse composante en utilisant les signaux de synchronisation de la première porteuse composante, et dans lequel la seconde valeur ordonne au terminal sans fil (110-1) de synchroniser et/ou configurer la deuxième porteuse composante sans utiliser les signaux de synchronisation de la première porteuse composante.

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21. Terminal sans fil (110-1) configuré en vue d'une communication avec un réseau d'accès radio (1330) qui transmet une première porteuse composante incluant des signaux de synchronisation sur une première fréquence, le terminal sans fil (110-1) étant **caractérisé par** :

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un processeur (1312) configuré de manière à :

recevoir, sur ladite première porteuse composante, des informations associant la première porteuse composante à une deuxième porteuse composante, qui doivent être reçues sur une deuxième fréquence, dans lequel les informations sont reçues en provenance du réseau d'accès radio ;  
recevoir une instruction visant à ajouter la deuxième porteuse composante en tant qu'une liaison descendante pour des transmissions allant du réseau d'accès radio au terminal sans fil (110-1), et synchroniser et/ou configurer la deuxième porteuse composante sur la deuxième fréquence en utilisant les signaux de synchronisation de la première porteuse composante sur la première fréquence, en réponse à la réception de l'instruction visant à ajouter la deuxième porteuse composante, dans lequel le processeur (1312) est configuré de manière à :

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recevoir l'instruction visant à ajouter la deuxième porteuse composante en recevant un drapeau présentant l'une parmi une première valeur et une seconde valeur ; et

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synchroniser et/ou configurer la deuxième porteuse composante en synchronisant et/ou en configurant la deuxième porteuse composante en utilisant les signaux de synchronisation de la première porteuse composante en réponse à la réception du drapeau présentant la première valeur ; et  
synchroniser et/ou configurer la deuxième porteuse composante sans utiliser les signaux de synchronisation de la première porteuse composante en réponse à la réception du drapeau

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présentant la seconde valeur.

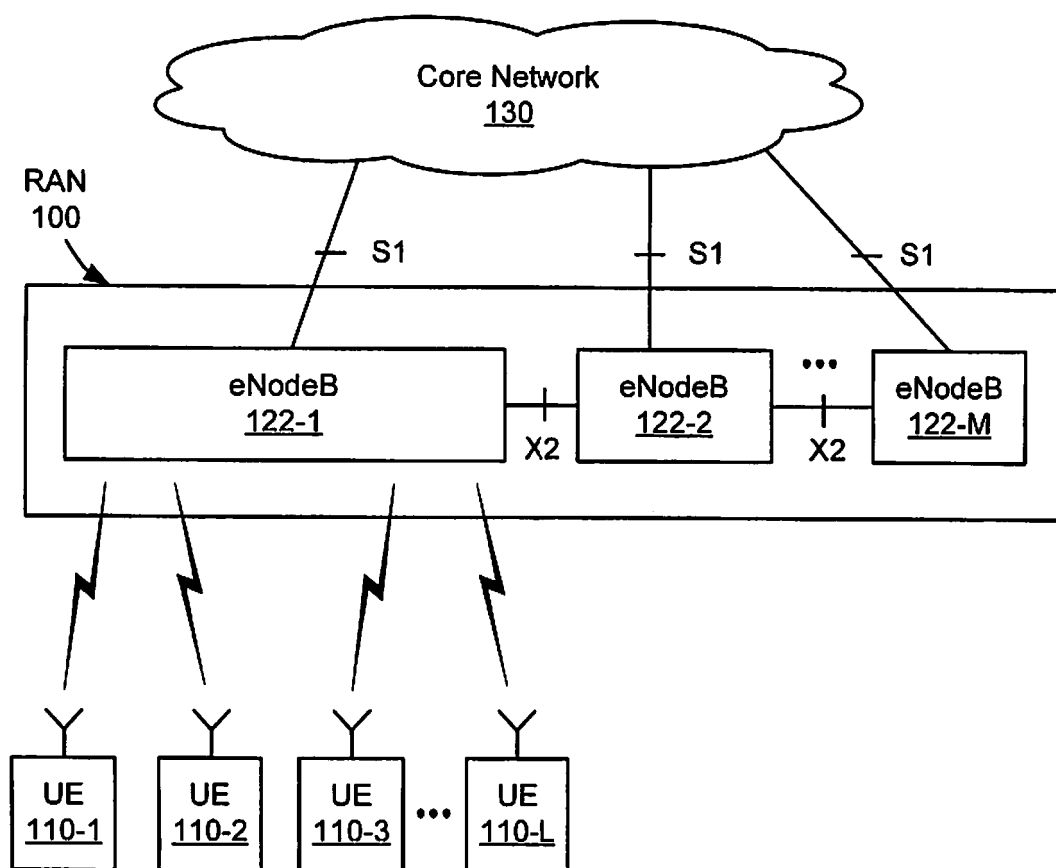


**Figure 1**

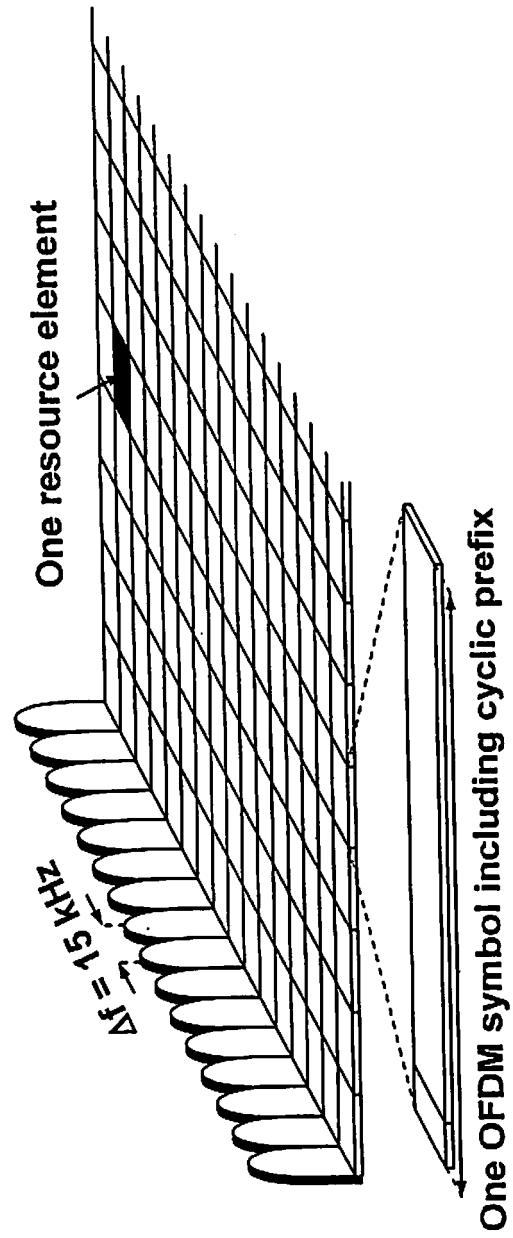


**Figure 2**

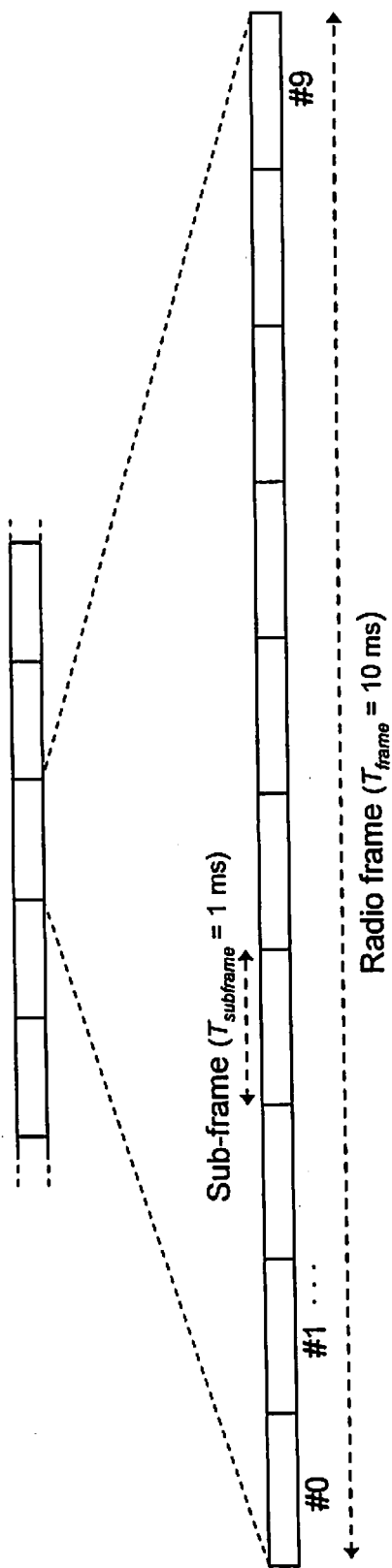


Figure 3

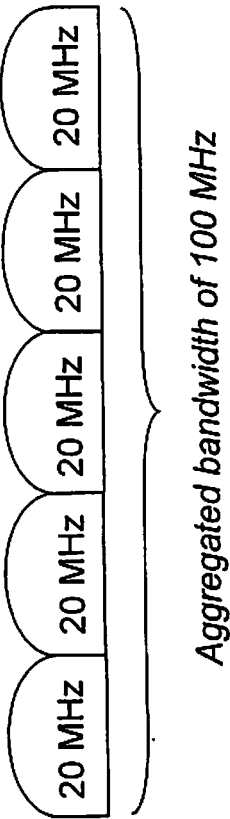


Figure 4

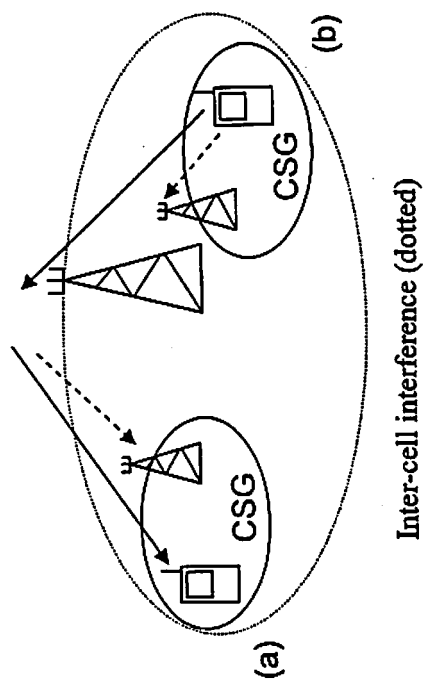


**Figure 5A**

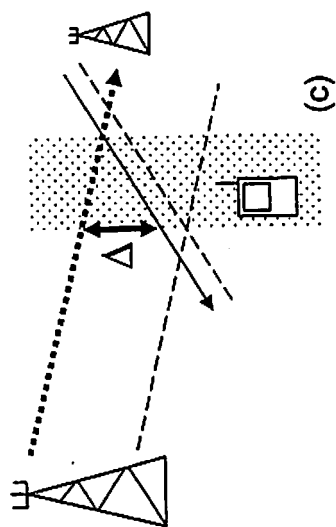


**Figure 5B**

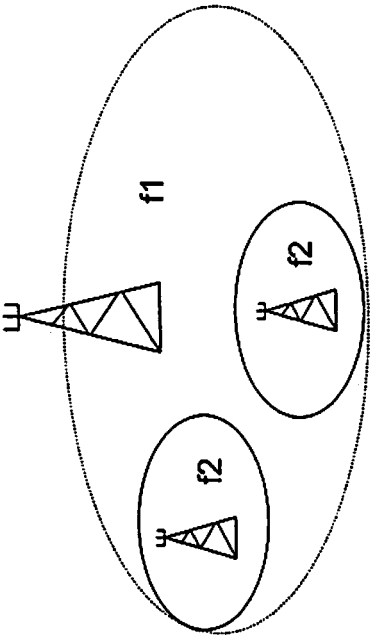
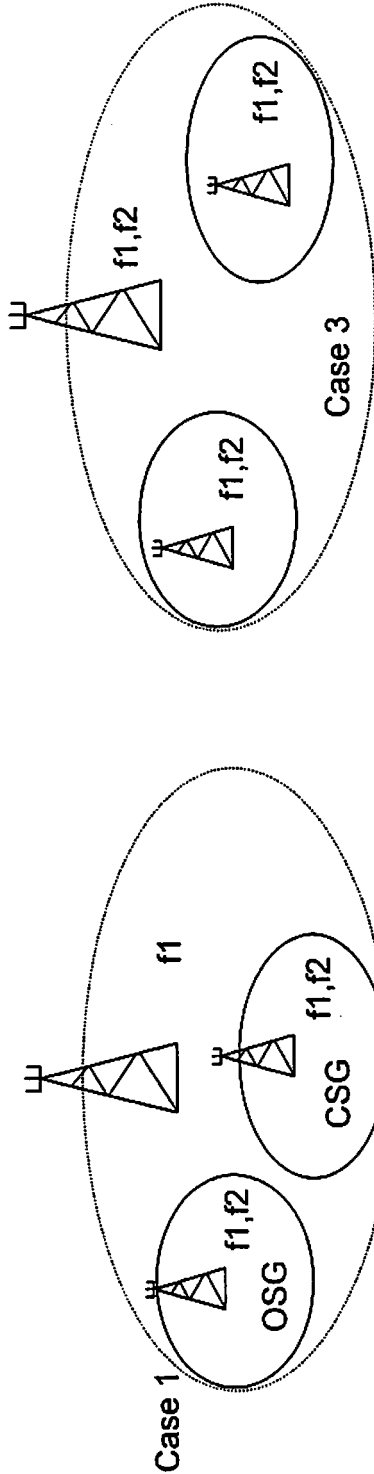


Figure 6



Case 2

Figure 7B

Figure 7A

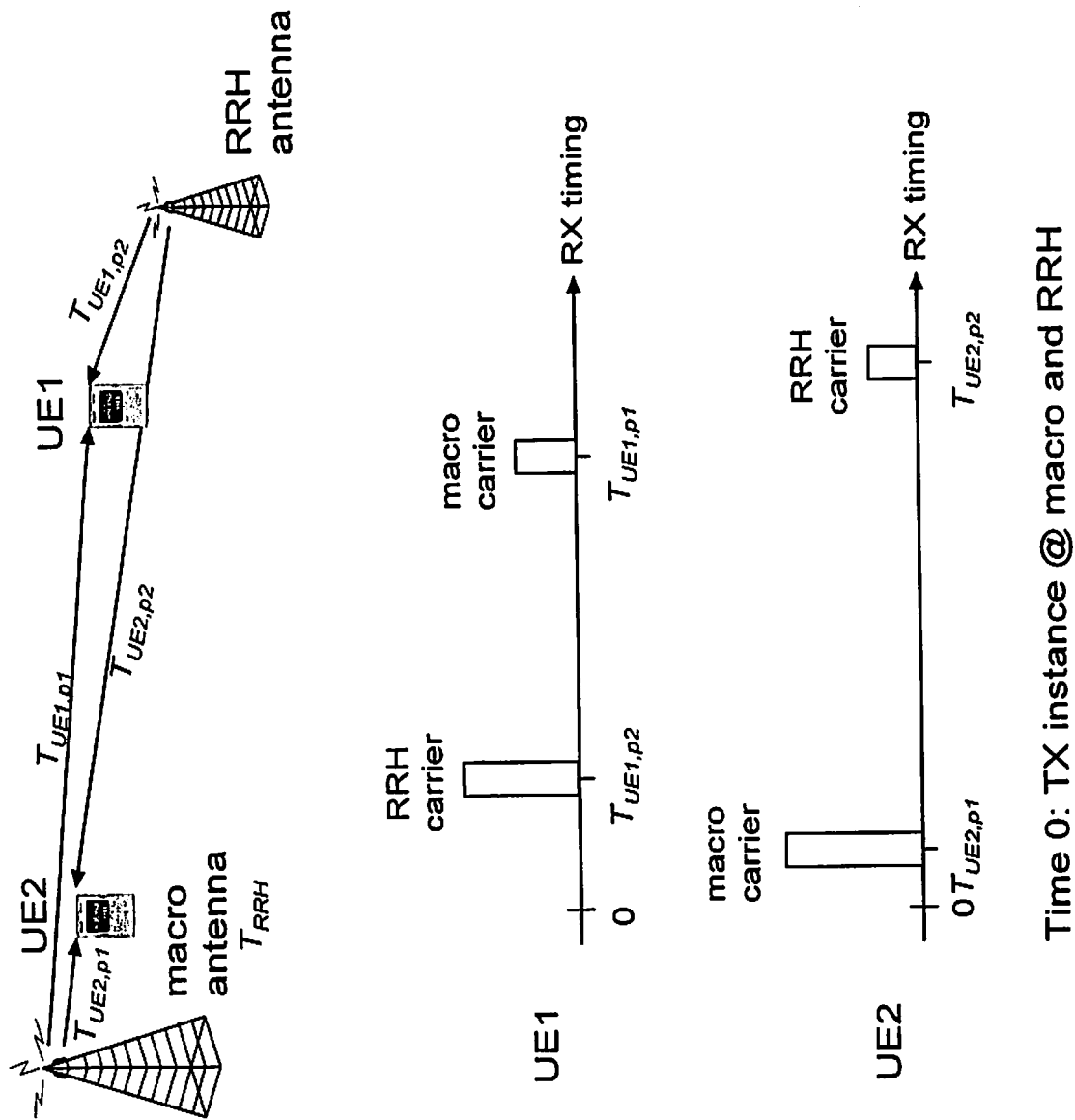
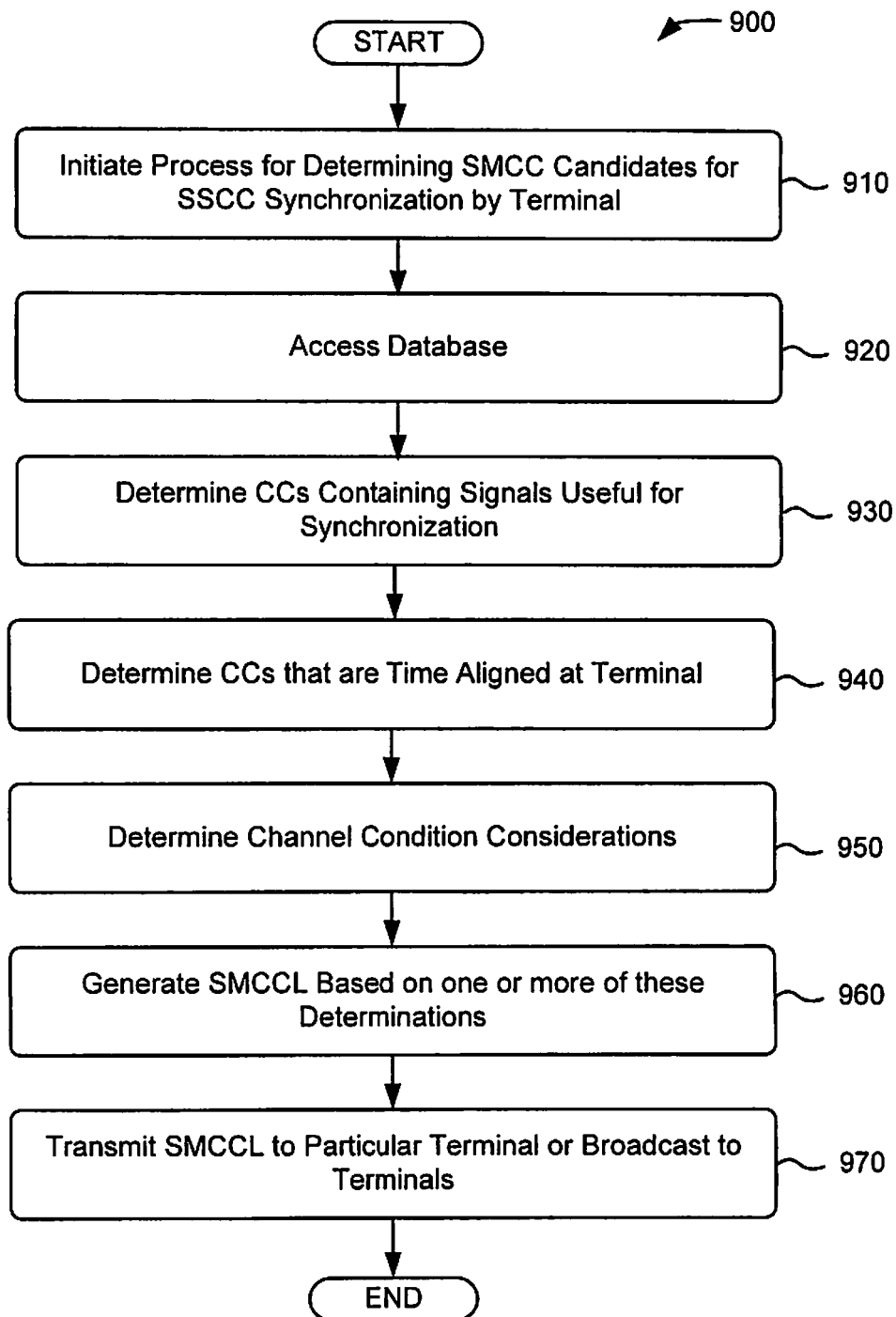
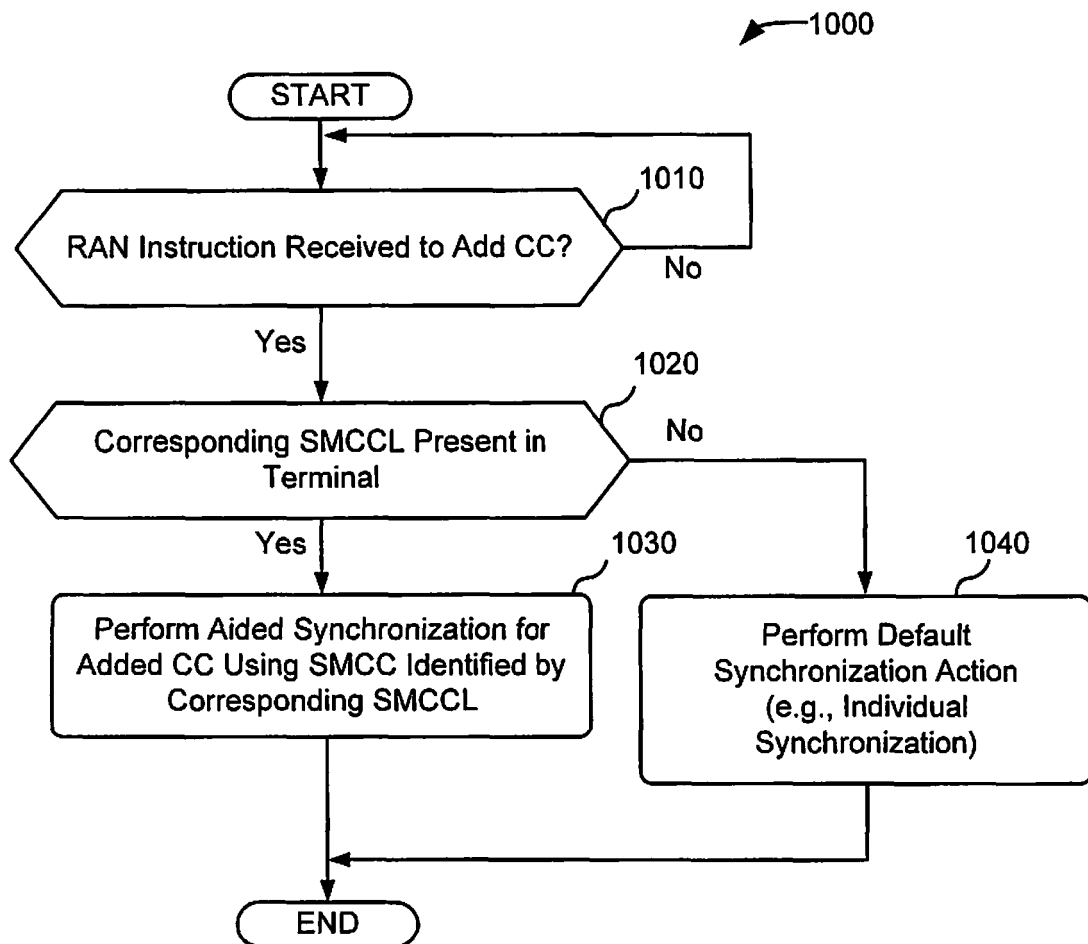
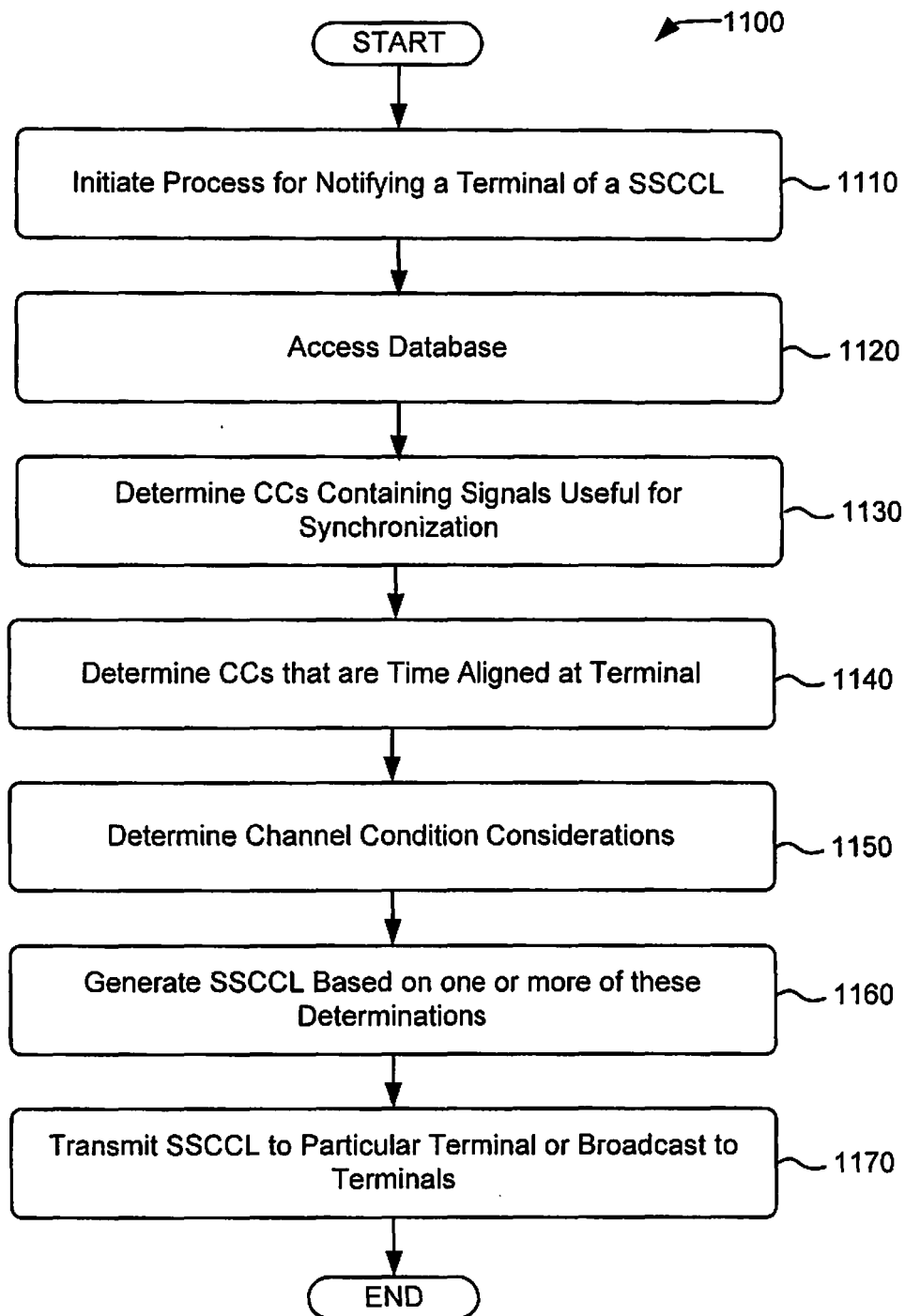
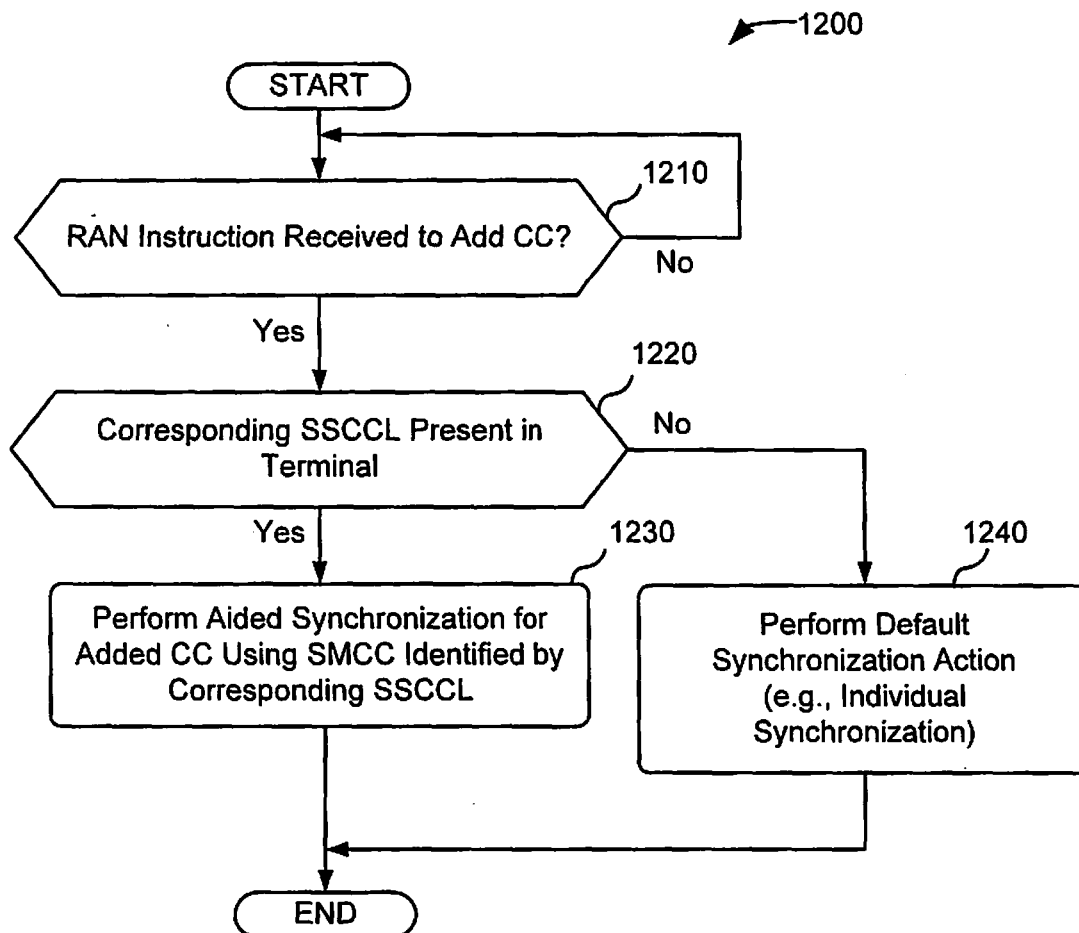


Figure 8

**Figure 9**

**Figure 10**

**Figure 11**

**Figure 12**

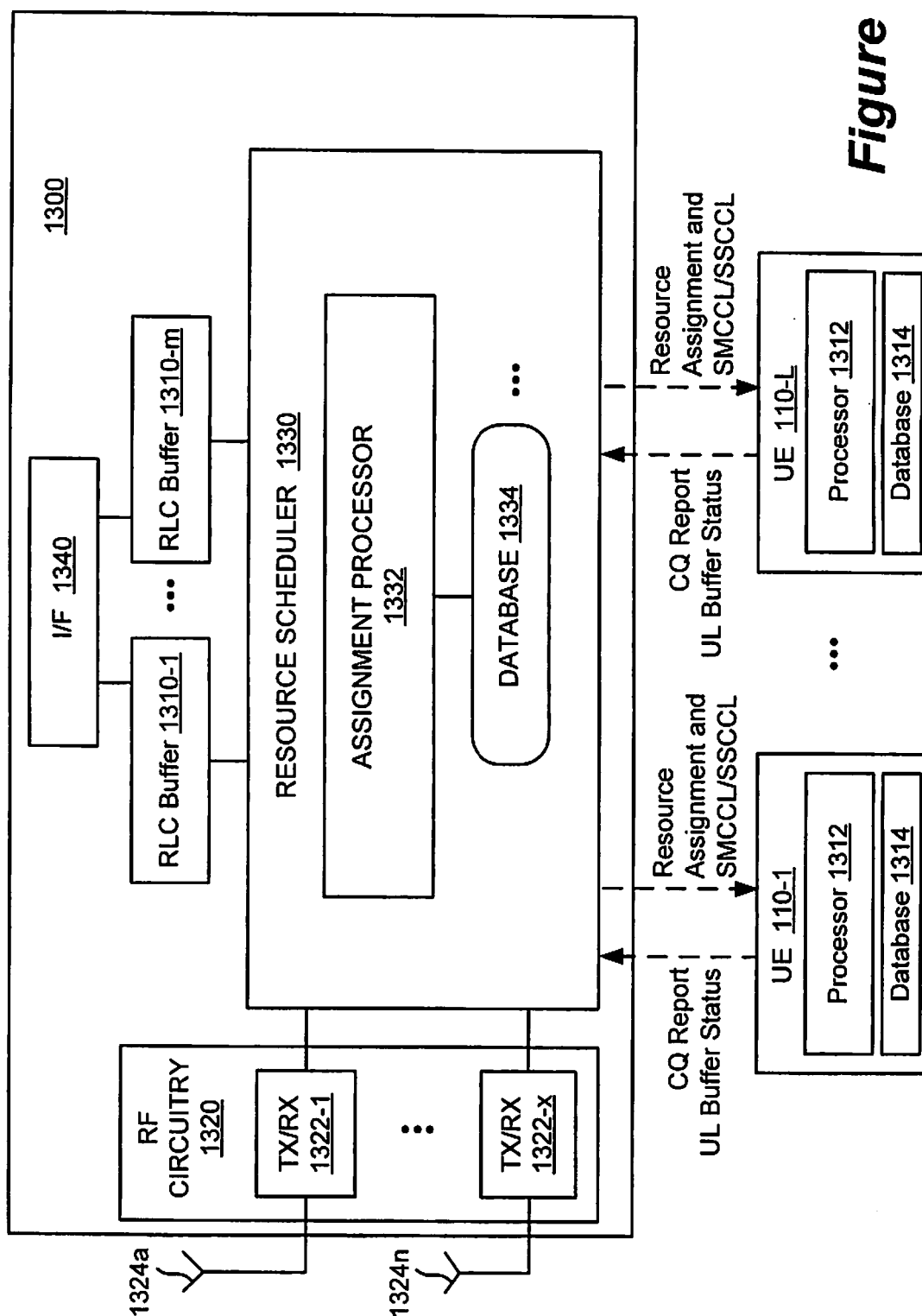
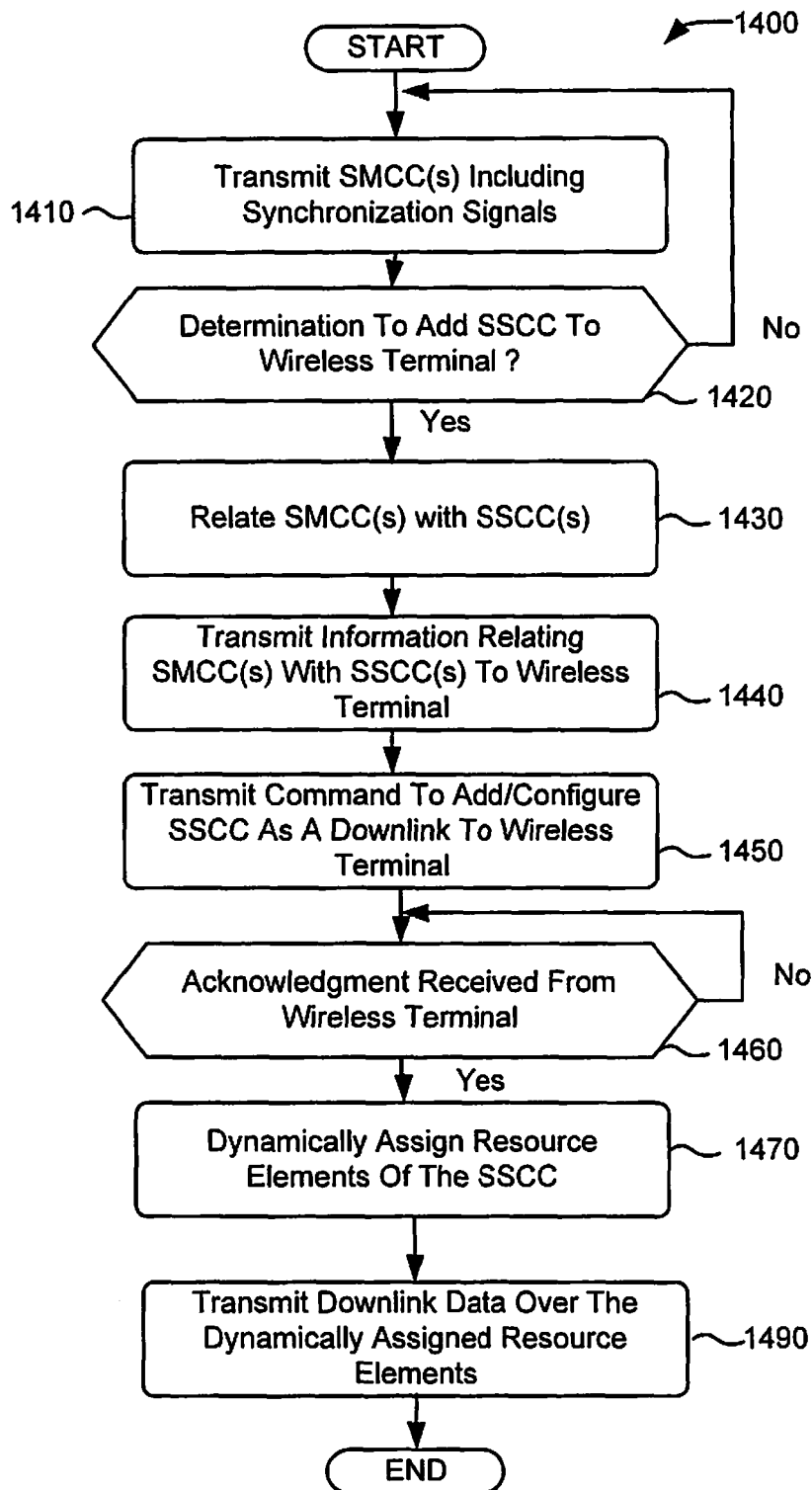
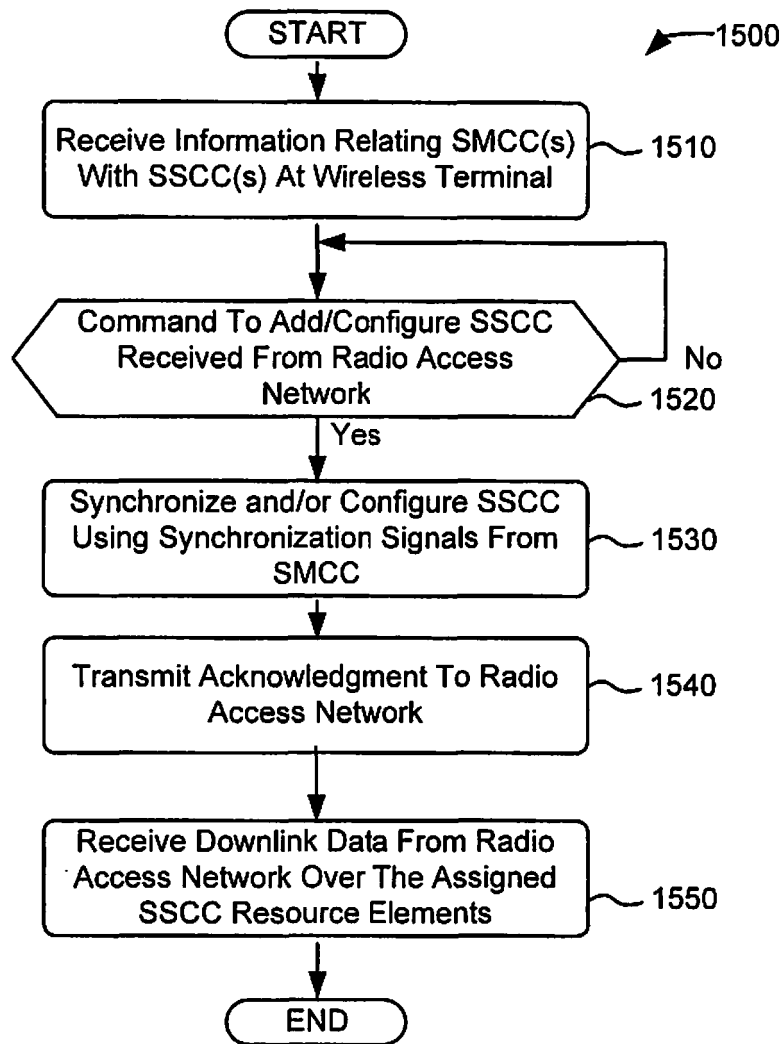


Figure 13

**Figure 14**

**Figure 15**